FRENCH LIMITED SITE
CROSBY, TEXAS

Groundwater Evaluation & Risk Assessment

Prepared for:

French, Incorporated
Crosby, Texas

Submitted to:

U.S. Environmental Protection Agency
Region 6
Dallas, Texas

Prepared by:

Applied Hydrology Associates, Inc.
Denver, Colorado

February 2003

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Prepared for:

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1.0 INTRODUCTION

This report addresses several small plumes of impacted groundwater remaining at the French Limited site. The plumes include benzene and vinyl chloride extending southwesterly from the west end of the lagoon (west INT plumes), and overlapping S1 and INT plumes of mixed chlorinated chemicals at the S1-123/INT-130R area. This report evaluates the fate and transport of these dissolved chemicals and the potential risk posed to public health and the environment by each of these plumes.

1.1 Site Background

The French Limited site is adjacent to old US-90 in eastern Harris County, about 20 miles northeast of Houston. The site is within the floodplain of the San Jacinto River as shown in Figure 1-1, and was quarried for sand in the 1950's and 1960's. An abandoned sand pit of about eleven acres that had filled with water to form a pond ("lagoon") was permitted to accept industrial waste material from 1966 through 1971. In this period, the site accepted about 90 million gallons of chemical waste, resulting in the formation of a chemical-rich sludge at the bottom of the lagoon. Some neutralization of the lagoon water was performed in 1971 – 72, and the site did not operate as a disposal site after 1973. In 1982, the EPA placed the site on the National Priorities List (NPL) and designated it for remedial action under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, or "Superfund").

Potentially Responsible Parties (PRP's) called upon to manage the remediation program at the site formed the French Limited Trust Group in late 1983. Remedial Investigation/Feasibility Studies (RIFSs) were completed between 1984 and 1986. Field pilot studies of potential remedial technologies were conducted in 1987, and EPA issued the Record of Decision (ROD) in 1988. A sheet pile protective floodwall was constructed around the former sand pit or lagoon in 1989. The sheet piling was driven through the base of the shallow sandy units into an underlying clay unit to form a subsurface barrier to groundwater flow in those sandy units. The biological treatment system for the lagoon source area and the surrounding affected shallow groundwater was designed in 1990 and constructed during 1991.

A corporation, FLTG, Inc. (FLTG), was set up to manage remedial operations and post-remediation monitoring. Active remedial activities occurred at the site during the four-year period from January 1992 through December 1995. The chemical sludges in the lagoon were remediated by biotreatment inside the sheet pile wall from 1992 through 1993. Groundwater in the S1 and INT intervals was remediated by flushing and in situ bioremediation during the four year active remediation period. Potable deep well water amended with nutrients and electron acceptors (oxygen and nitrate) was injected into the affected groundwater zones, and pumped water was treated in the wastewater facility prior to discharge to the river.

A few affected groundwater areas outside of the lagoon sheet pile wall were identified as being impacted by residual dense, non-aqueous phase liquids (DNAPLs). One of these groundwater "hot spots" on the south central side of the lagoon was contained by a sheet pile addition (the INT-11 enclosure) in 1995. Monitoring wells outside the main lagoon and extension walls showed that the sheet-pile walls have very low permeability, and there is no measurable chemical migration across them.

The active remedial system was operated until natural attenuation processes could be expected to complete the attainment of clean-up criteria within ten years, based on groundwater transport and bioattenuation modeling. By the end of 1995, groundwater cleanup criteria had been met and maintained, except for a few isolated areas. Groundwater modeling studies demonstrated that natural attenuation processes should be capable of attaining cleanup criteria within the ten-year time frame, assuming that there were no continuing sources of chemicals to the groundwater. In December 1995 the site entered into a phase of long-term monitoring to track the progress of natural attenuation to achieve remedial criteria. For the first two years of this program, quarterly groundwater sampling was performed on a selected number of monitoring wells. After 1998, the monitoring frequency was reduced to semi-annual.

The results of groundwater monitoring since 1995 have shown that concentrations of characteristic chemical constituents in groundwater have, by and large, decreased as predicted over the site. The following exceptions have caused EPA to request evaluation of current and future risk, and review of potential response actions:

1. A plume in the INT unit, containing benzene, 1,2 dichloroethane, and vinyl chloride, extending southwesterly from the west end of the sheet pile enclosure to the INT-144 monitoring well;
2. A benzene and vinyl chloride plume in the INT unit extending southwesterly from the west-central part of the sheet pile enclosure to the INT-217 monitoring well;
3. Overlapping plumes in the S1 and INT horizons in the east end of the site, centered on wells S1-123 and INT-130R. Over the last three years, chlorinated hydrocarbon concentrations have increased in S1-123 (completed in the S1), and held steady in INT-130R (completed in the INT unit).

The locations of these focused investigation areas and monitoring wells are shown in Figure 1-2. In this report, the benzene and vinyl chloride plumes in the INT in the southwest are collectively referred to as the INT west plumes; and the S1-123 / INT-130R area S1 and INT plumes as the east plumes.

1.2 Previous reports

Major relevant reports on the French site are summarized in Table 1-1. Numbers in the left of the table are the Crosby library catalog numbers, which are also used as references in this report.

1.3 Regulatory basis

The French Limited site Record of Decision (ROD)[1], states "Groundwater recovery and treatment will continue until modeling shows that a reduction in the concentration of volatile organics to a level which attains the 10^{-6} Human Health Criteria can be achieved through natural attenuation in 10 years or less" and "The final component ... involves post-closure monitoring of the upper and lower aquifers for a period of 30 years." The upper aquifer is understood to consist of the alluvial S1 and Beaumont INT units, together; the lower aquifer is isolated from the upper by 70 feet of Beaumont Clay.

The ROD defines the site to be a triangular area whose boundaries include the north side of Gulf Pump Road to the south, the south side of the former US Highway 90 easement to the north. The southern compliance boundary is the south side of Gulf Pump Road. The site boundary is shown in Figure 1-1 along with significant surrounding features, including the communities of Barrett and Riverdale, the San Jacinto River and flood plain, and nearby highways and roads.

The Natural Attenuation Modeling Report (1995)[2] stated that: "Modeling was performed to demonstrate that [natural attenuation] processes would result in site cleanup criteria being met at and beyond the compliance boundary within ten years, in accordance with the Record of Decision (ROD) for the site." Section 12 of the Site Closure Plan[3] presented the post-closure groundwater monitoring plan for the period 1996 through 2025. As the regional groundwater hydraulic gradient is to the south-southwest, compliance monitoring wells were established in the Site Closure Plan at locations south of the site. Due to the presence of the road and its drainage ditches, buried communications lines, and overhead power lines in this corridor, the compliance monitoring wells could not reasonably be located immediately south of Gulf Pump Road. Therefore, the current effective compliance boundary is approximately 30 feet south of Gulf Pump Road.

[1] Superfund Record of Decision: French Limited, TX. USEPA, March 1988. EPA/ROD/R06-88-030.

[2] FLTG, Crosby, Texas, Natural Attenuation Modeling Report, Applied Hydrology Associates, Dec. 1995.

[3] Site Closure Plan, French Limited Facility Project, Crosby, Texas (Southwestern Environmental Consulting, Inc., January 1996.

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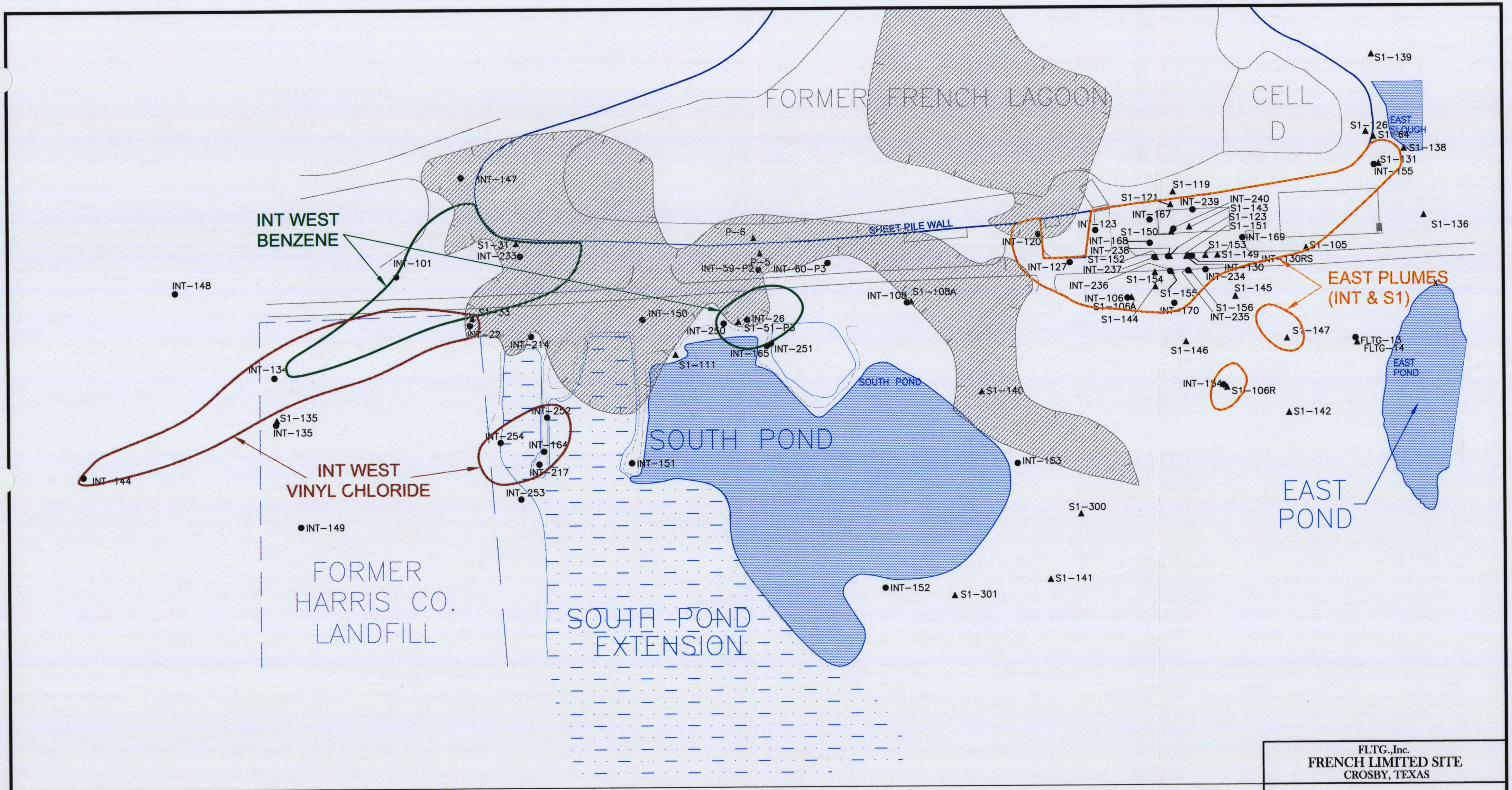
FIGURE 1-1
FRENCH LIMITED SITE
AND SURROUNDING AREA 1995

DESIGN: TWG	DATE: 08 Jan 03	FILE NAME: S:\026-French Limited\Aerial Photos\frenchaerialphoto1995_12jun02.apr
DRAWN: IAS	SCALE: As Shown	
SCRIPT:		



LEGEND

- ● INT WELLS
- ▲ S1 WELLS
- SHEET PILE WALL
- C1 CLAY ABSENT

100' 0 100'

SCALE IN FEET

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N

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FIGURE 1-2
LOCATIONS OF AREAS OF INVESTIGATION

DESIGN:	MD	DATE: 11/26/02	DRAWING NUMBER	
DRAWN:	JLS	SCALE: AS SHOWN	FRENCH.DWG	
SCRIPT:				

Table 1-1
Past technical reports on French Limited Site
from repository report: January, 2000

Numbers are those assigned by the Crosby Library:

1.	Remedial Investigation Report - June, 1986
5.	Field Investigation and Supplemental Remedial Investigation Report, December, 1986
7	Field Investigation Hydrology Report, December 19, 1986
8	Feasibility Study Report, March 1987
10	French Focused Feasibility Study, May 1987
12	Endangerment Assessment Report April 1987
14	In-Situ Biodegradation Demonstration Report October, 1987 (Revised 12-15-87)
19	In-Situ Biodegradation Demonstration Supplemental Report Vol. IV, Nov. 1987 - Appendices
23	Consent Decree between the Federal Government and the French Limited Trust Group
25.	Laboratory Evaluation of Biodegradation at the French, December 1986
26	Field Evaluation of Biodegradation at the French March, 1987
27.	Bioremediation Facilities Design Report March, 1991
28.	Remedial Action Plan, September, 1990
36.	Hydrogeologic Characterization Report, Applied Hydrology Associates, March 1989
42.	San Jacinto River May 19, 1989 Flood Event Report, June, 1989
46.	Slough Investigation Report French, October, 1988
47.	Flood and Migration Control Wall Design Report, August 16, 1989
55.	Workplan for the Shallow Aquifer Pumping Tests for the French, July 22, 1988
57.	Riverdale Lake Area Remediation Program, August 15, 1989
61.	Ambient Air Impact Risk Assessment Report, May 5, 1989
62.	Shallow Aquifer and Subsoil Remediation Facilities Design Report, July 1991
65.	Remediation Design Report Executive Summary Bioremediation Shallow Aquifer July 1991
79.	DNAPL Study Remedial Alternative Selection and Feasibility Study Report, November 1994
89.	Superfund Preliminary Site Closeout Report CERCLIS TXD-980514814, September, 1994
91.	INT-11 DNAPL Area Cutoff Wall Installation and Permeability Certification Report, Aug.. 1995
93.	Site Closure Plan, South-Western Environmental Consultants, January, 1996
94.	Superfund Site Close Out Report, CERCLIS TXD-98514814, CH2M Hill, June 1996

FLTG now has control through lease and ownership of property south of Gulf Pump Road containing all off-site areas that are currently impacted by chemicals in groundwater. FLTG is consolidating this control through additional purchases to extend well beyond the areas that are currently impacted by chemicals in groundwater.

The location of French-controlled property, forming an institutional control buffer upgradient of any potential future exposure point, is shown in Figure 1-1, and also in more detail in Figure 5-1.

EPA's Second Five Year Review Report[4] concluded:

> "Contaminant levels in site groundwater have decreased over time, indicating that natural attenuation is occurring on the site. The groundwater remedy is expected to be protective of human health and the environment upon completion, and immediate threats have been addressed. Although not an immediate threat to human health or environment, portions of the SI and INT groundwater units may not meet compliance criteria at the end of the progress monitoring in 2005. Monitoring and further characterization of these areas is needed. Additional remedial actions may be necessary to achieve the compliance criteria. Potential exposure of Riverdale residents has been eliminated by aquifer remediation and installation of a new deep potable water well. The previous Riverdale drinking water wells have been converted to monitoring wells, and land that the wells were located on has been purchased. The lagoon area is completely fenced and the FLTG has control of properties where groundwater is exceeding compliance standards. The FLTG is continuing efforts to purchase the property south of Gulf Pump Road so this property could be used for long-term institutional controls."

The portions of the S1 and INT groundwater units referred to in the above extract from the Second Five Year Review Report include the area immediately south of the sheet pile cutoff wall approximately centered on monitoring wells S1-123 and INT-130. In the latter half of 2002, EPA requested the focused feasibility study for this area be extended to include the INT west plumes.

[4] Second Five Year Review Report, EPA, 2000.

2.0 SUBSURFACE CONCEPTUAL MODEL

2.1 Geology

The entire site lies within the floodplain of the San Jacinto River. The floodplain has recent alluvial deposits consisting largely of sand (S1) to a depth of about 35 feet, with a surface veneer of unconsolidated silt (UNC) in the vicinity of the site. These sediments were deposited by the San Jacinto River within a channel incised in the Late Pleistocene lower Beaumont Formation. The underlying Beaumont Formation (or Beaumont Clay), consists of an upper clay (C1) and an interbedded sand and silt unit (INT). The UNC through INT units may be correlated across the site (AHA, 1989 [14]). The INT was previously identified as another alluvial unit of the San Jacinto River, but a recent cone penetrometer boring outside the floodplain shows that it is part of the regional Beaumont (it is present near the junction of Gulf Pump Road and old Highway 90). The descriptions of the alluvial units and the underlying Pleistocene and older formations are summarized in Table 2-1.

TABLE 2-1
Hydrogeologic Units at French Site.

Formation	Unit	Approx. Depth (ft)	Description
Quaternary and Recent	**UNC**	0 to 10	Silty and clayey, medium to fine sand mixed with variable amounts of natural organic matter. Unit represents over bank flood deposits and reworked S1 sand.
	S1	10 to 30	Clean medium to coarse sand with minor amounts of fine gravel. Unit represents primary fluvial channel deposits.
Beaumont Formation (Pleistocene)	**C1**	30 to 35	Laterally discontinuous clay with minor thin silt layers. Where present, it functions as an aquitard between the S1 and INT units.
	INT	35 to 55	Interbedded fine sand and clayey silt.
	C2	55 to 200	Dominantly clay deposit with minor thin silt and fine sand layers. In the site area a 10 foot sand layer, the **S2 Unit,** occurs at a depth of 125 feet.
	Chicot and Evangeline aquifers	200 to 2400	A sequence of fluvial-deltaic sands, silts and clays. The primary groundwater supply for Houston (use greatly abridged in mid 1970s).

The Beaumont below the INT consists of clay with silt and sand lenses, and is an aquitard between the S1-INT zone and the underlying regional Chicot Aquifer (1, 5, 7). In earlier reports and in the ROD, the INT and S1 are grouped together as the "upper aquifer", and the Chicot aquifer beneath the Beaumont is referred to as the "lower aquifer". The S1 and INT are hydraulically connected where river scour cut through the C1. Areas of intersection of the S1 and INT are discussed in more detail below as "C1 windows".

The near-surface stratigraphy of the area is shown in two, north-south and east-west cross sections locations. The locations of the sections are shown in Figure 2-1, and the sections are in Figure 2-2. These cross sections are taken from the 1993 AHA DNAPL investigation (79). They show the C1, which isolates the S1 from the INT, missing in several areas.

The location of communication between S1 and INT through C1 windows is important to consideration of solute and DNAPL migration. The C1 windows were originally mapped in the early 1990s, and were recently updated. In July, 2002, a number of cone penetrometer borings were made in this vicinity to assess the C1 continuity, particularly with regard to possible isolation measures. Lithology data from borings for the INT-11 cutoff extension, which had not been incorporated in a C1 windows revision, are included with cone penetrometer data in Figure 2-3, which substantially updates the map in this area. The cone penetrometer and INT-11 boring data did not indicate any C1 windows in the S1-123 area, and also indicates that previously identified windows at the South Pond and inside the lagoon are not connected.

2.2 Hydrogeology

The S1 and INT are the two shallow aquifers of concern (together, they are the "upper aquifer" of the ROD). Previous investigations (e.g. 1, 36) have all concluded that the groundwater in the S1 and INT units are hydraulically separated from the underlying Chicot Aquifer by a low permeability clay unit (C2) within the lower Beaumont Formation, which is an aquiclude (a saturated formation incapable of transmitting significant flow under normal gradients). Historic pumping lowered water levels (potentiometric pressures) in the Chicot, so that an originally upward gradient from the Chicot to the lower reach of the river was reversed in the mid 1900's.

The S1 and INT are separated by the discontinuous C1 clay, which is an aquitard where present. The potentiometric surface maps in Figures 2-4 and 2-5 show the windows in the C1, where the S1 is known to be directly connected to the INT, based on drilling through 2001. As noted above, the delineation of gaps in the C1 has changed in 2001 and 2002, initially by anecdotal reports from a driller, and subsequently through a cone penetrometer survey of the area of the east plumes.

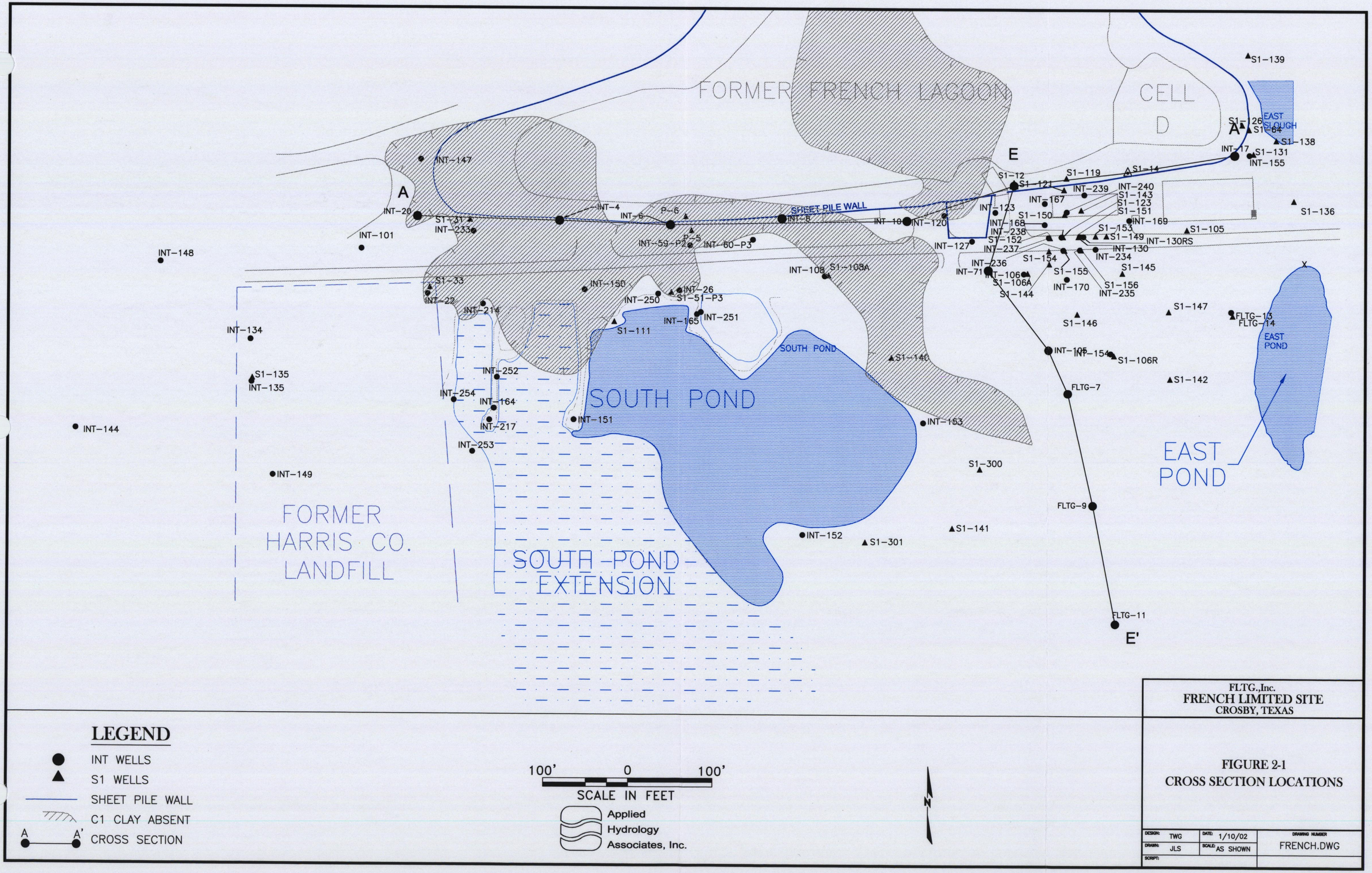

FIGURE 2-1
CROSS SECTION LOCATIONS

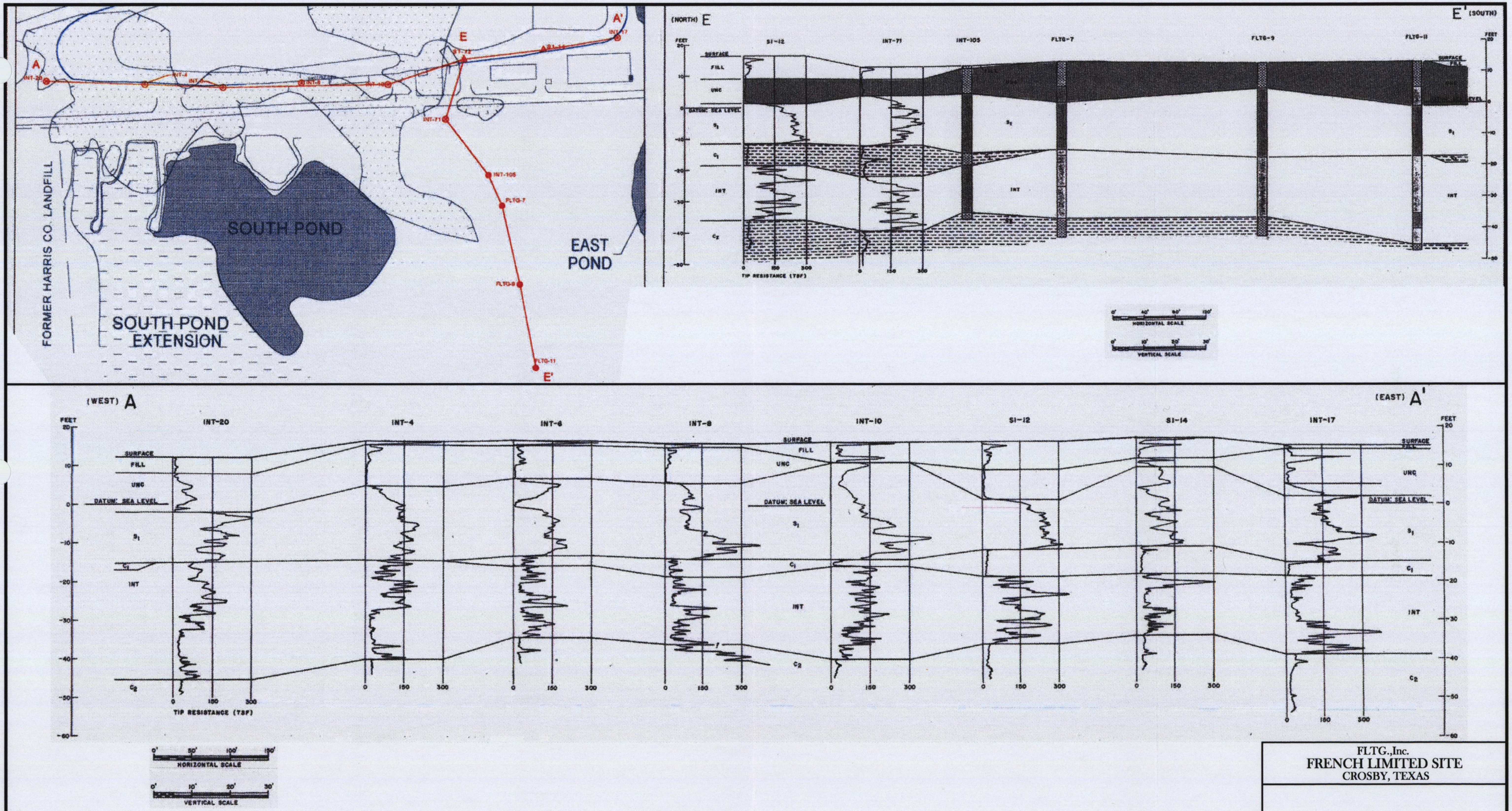

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FIGURE 2-2
STRATIGRAPHIC CROSS SECTIONS

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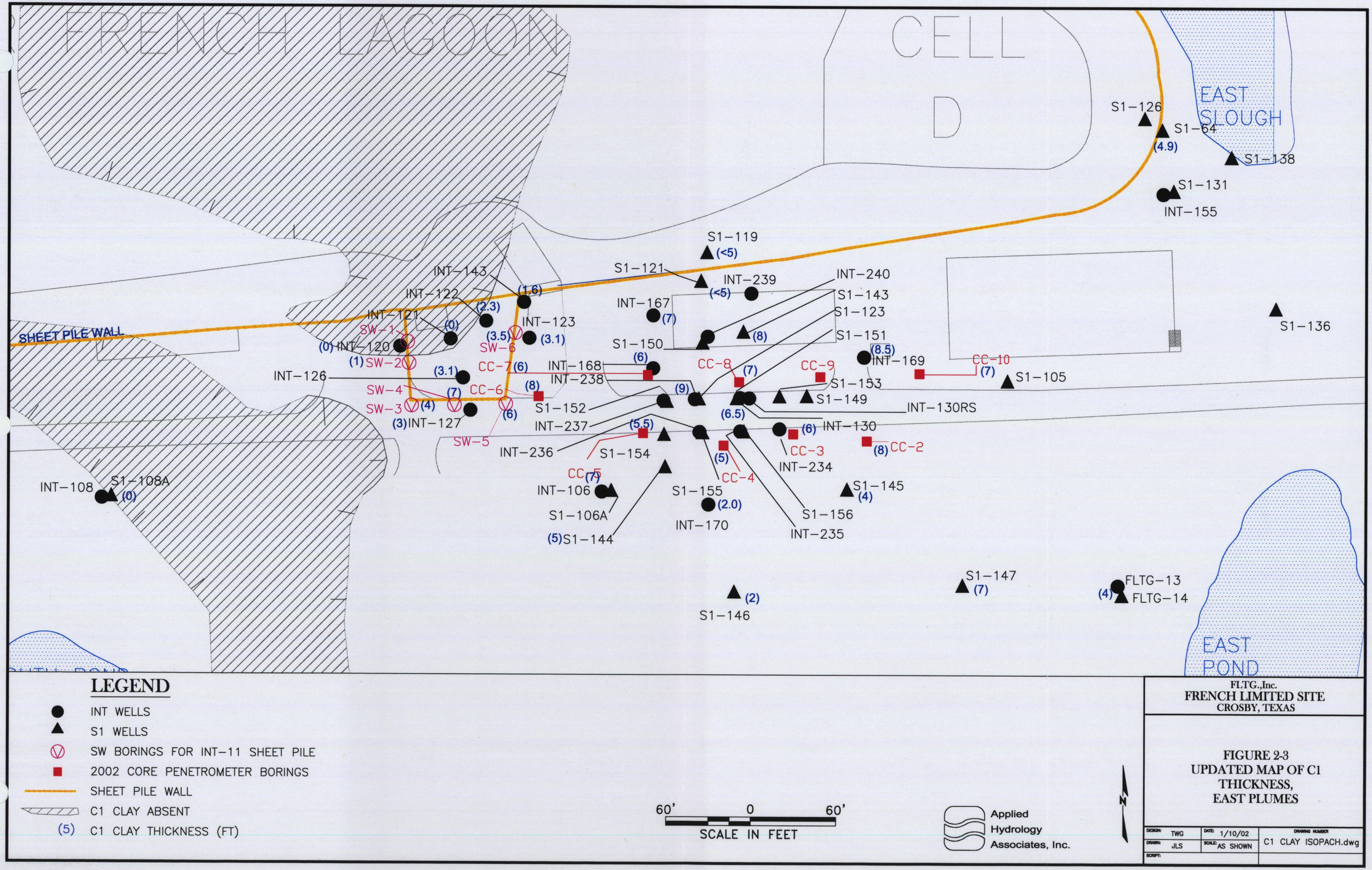
DESIGN: MD	DATE: 11/26/02	DRAWING NUMBER
DRAWN: JLS	SCALE: AS SHOWN	Stratigraphic X-Sections.dwg
SCRIPT:		


FRENCH LAGOON
CELL D
EAST SLOUGH
EAST POND
SHEET PILE WALL
S1-126
S1-64
(4.9)
S1-138
S1-131
INT-155
S1-119
(<5)
S1-121
(<5)
INT-239
INT-240
S1-143
S1-123
S1-151
INT-167
(7)
(8)
S1-150
(6)
S1-136
INT-143
(1.6)
INT-122
(2.3)
INT-121
(0)
INT-123
(3.5)
(3.1)
SW-1
SW-6
(0) INT-120
(1) SW-2
INT-126
(3.1)
CC-7 (6)
INT-168
INT-238
CC-8
(7)
CC-9
(8.5)
INT-169
CC-10
(7)
S1-105
SW-4
(7)
CC-6
(8)
S1-153
S1-149
SW-3
(4)
(9)
S1-152
(6.5)
INT-130RS
(3) INT-127
(6)
INT-237
(5.5)
(6)
INT-130
SW-5
INT-236
S1-154
(5)
CC-3
(8)
CC-2
INT-234
CC-5
(7)
CC-4
S1-145
(4)
INT-108
S1-108A
(0)
INT-106
S1-155
(2.0)
S1-156
S1-106A
INT-170
INT-235
(5) S1-144
S1-147
(7)
FLTG-13
(4)
FLTG-14
(2)
S1-146
LEGEND
INT WELLS
S1 WELLS
SW BORINGS FOR INT-11 SHEET PILE
2002 CORE PENETROMETER BORINGS
SHEET PILE WALL
C1 CLAY ABSENT
(5) C1 CLAY THICKNESS (FT)
60' 0 60'
SCALE IN FEET
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FLTG.,Inc.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-3
UPDATED MAP OF C1 THICKNESS, EAST PLUMES
DESIGN: TWG
DATE: 1/10/02
DRAWN: JLS
SCALE: AS SHOWN
DRAWING NUMBER C1 CLAY ISOPACH.dwg

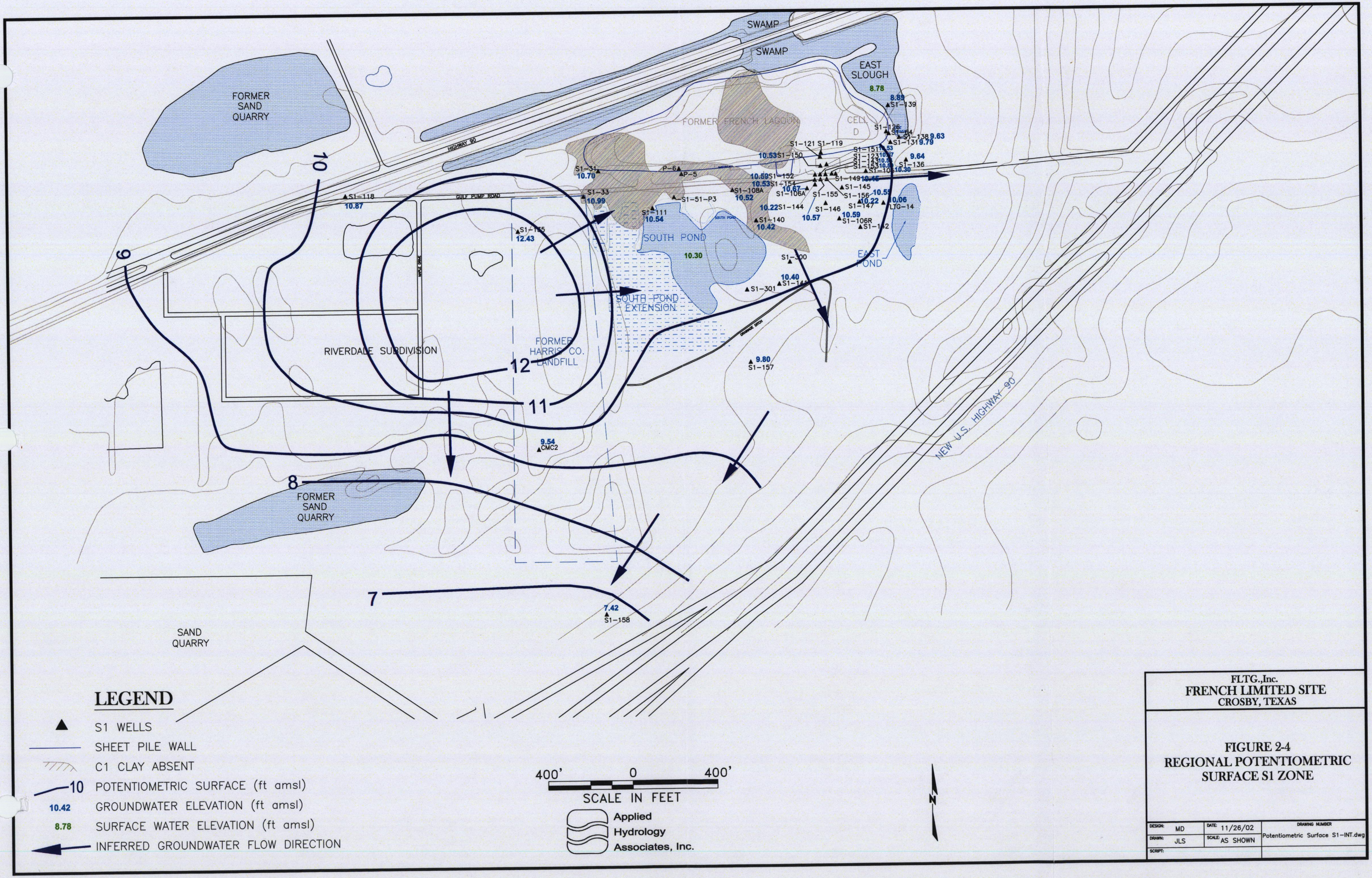
The UNC cover is a thin layer of flood silt and clay that is too heterogeneous and thin to confine the S1 The S1 is a relatively well-sorted, medium to coarse grained, unconsolidated sand. It has an average thickness of about 20 feet and a permeability ranging from 10^{-3} to 10^{-2} cm/sec (3-30 ft/day). Well yields in the S1 unit range from 2 to 15 gallons per minute (gpm). The INT is an interbedded silt and fine sand unit with thin clay zones. It has an average thickness of about 20 feet and an average permeability ranging from 10^{-4} to 10^{-3} cm/sec. Well yields in the INT unit range from 0.3 to 3 gpm.

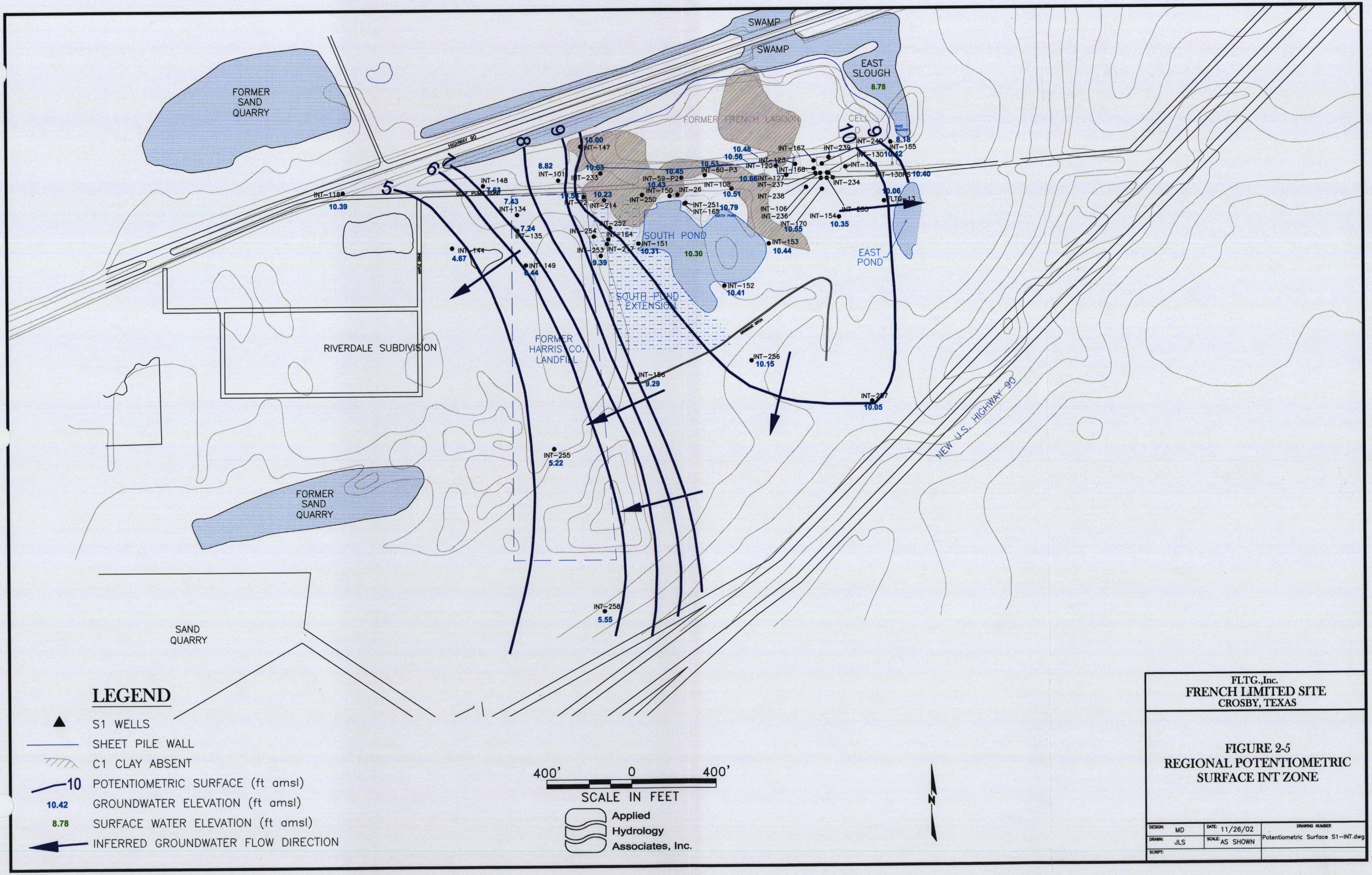
The potentiometric surfaces of the S1 and INT units at the site are shown in Figures 2-4 and 2-5 respectively. Prior to the installation of the sheet pile wall around the lagoon, groundwater flow was generally southwesterly, parallel to the flood plain. Local topographic highs such as the County landfill caused some variability in the S1 flow. The sheet pile diverted S1 and INT groundwater flows, and beaver dams elevated surface water in the south and east, further complicating shallow groundwater flow. North of the lagoon, the S1 and INT flows are now principally diverted to the west by the sheet pile enclosure. South of the sheet pile, the South Pond, whose surface has been raised as much as two feet by beaver dams, recharges both the S1 and the INT through the C1 window, creating mounds in both intervals. The South Pond has expanded westwards into marshy lowland up to the former Harris County landfill, and recharges the S1 over this extended area through the UNC. The elevated landfill now forms a more prominent local S1 groundwater divide.

Flows in the east plumes are driven by South Pond recharge easterly along the sheet pile toward the East Pond and East Slough. This S1 flow thence turns back southward along the edge of the floodplain.

The INT groundwater flow has a divide approximately near the south-central sheetpile. In the west plumes, INT groundwater flows southwesterly in the same direction as the general San Jacinto alluvial flow (but opposite to local S1 flow). In the east plumes, INT flow is easterly, and approximately parallel to the S1 flow, and is expected to turn south similar to the S1, probably re-connecting to the S1 at some distance down-valley where other windows in the C1 are likely to exist.

Hydraulic relations between ponds and eastern S1 groundwater is illustrated in Figure 2-6 hydrographs. The hydrograph of the East Slough (north of Gulf Pump Road) appears closely connected to the S1 groundwater potentiometric level in S1-131 (adjacent to the East Slough) and FLTG-14 (adjacent to the East Pond, south of Gulf Pump Road). The South Pond level does not fluctuate like the levels in the East Slough and the S1 wells in that area. Rather, the levels in the South Pond rise steadily through time as a result of a beaver dam elevating the outlet. Water levels in the broader South Pond are maintained by the beaver dam, net precipitation and runoff from the Harris County Landfill.


FORMER SAND QUARRY
SWAMP
SWAMP
EAST SLOUGH
8.78
HIGHWAY 90
FORMER FRENCH LAGOON
CELL D
GULF PUMP ROAD
SOUTH POND
10.30
SOUTH POND EXTENSION
EAST POND
RIVERDALE SUBDIVISION
FORMER HARRIS CO. LANDFILL
FORMER SAND QUARRY
SAND QUARRY
NEW U.S. HIGHWAY 90
10
9
12
11
8
7
S1-118
10.87
S1-31
10.70
S1-33
10.99
S1-135
12.43
S1-111
10.54
S1-51-P3
S1-108A
10.52
S1-140
10.42
S1-300
10.40
S1-301
9.80
S1-157
9.54
CMC2
7.42
S1-158
S1-121 S1-119
S1-150
S1-139
S1-136
S1-106R
S1-142
LTG-14
LEGEND
S1 WELLS
SHEET PILE WALL
C1 CLAY ABSENT
10 POTENTIOMETRIC SURFACE (ft amsl)
10.42 GROUNDWATER ELEVATION (ft amsl)
8.78 SURFACE WATER ELEVATION (ft amsl)
INFERRED GROUNDWATER FLOW DIRECTION
400' 0 400'
SCALE IN FEET
Applied Hydrology Associates, Inc.
N
FLTG.,Inc.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-4
REGIONAL POTENTIOMETRIC SURFACE S1 ZONE
DESIGN: MD
DRAWN: JLS
DATE: 11/26/02
SCALE: AS SHOWN
DRAWING NUMBER
Potentiometric Surface S1-INT.dwg

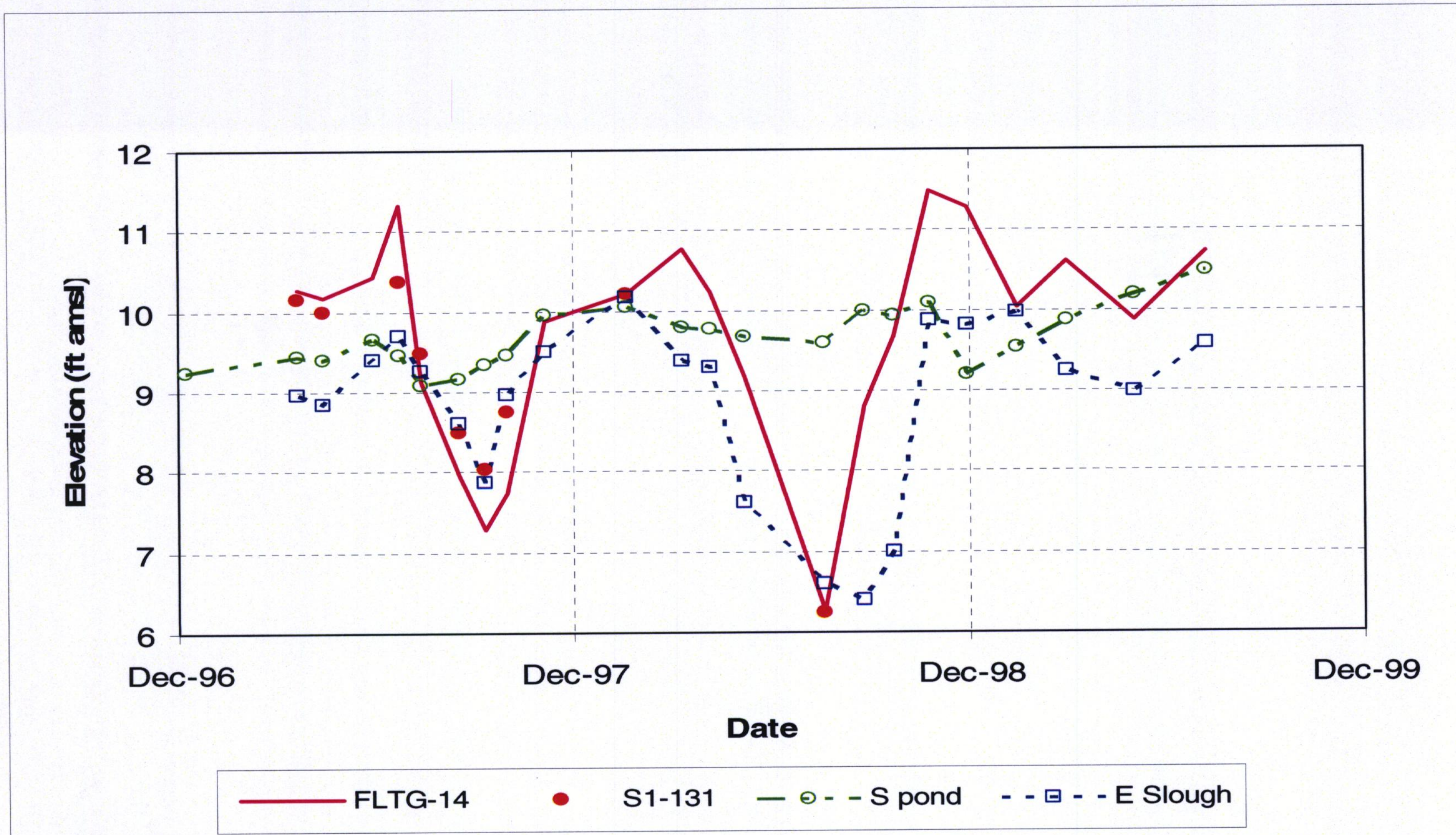

SWAMP
SWAMP
EAST SLOUGH
8.78
FORMER SAND QUARRY
FORMER FRENCH LAGOON
HIGHWAY 90
SOUTH POND
10.30
SOUTH POND EXTENSION
EAST POND
RIVERDALE SUBDIVISION
FORMER HARRIS CO. LANDFILL
FORMER SAND QUARRY
SAND QUARRY
NEW U.S. HIGHWAY 90
INT-118
10.39
INT-148
INT-134
7.43
INT-135
7.24
INT-144
4.67
INT-149
INT-101
8.82
INT-147
10.00
INT-233
10.63
INT-214
10.23
INT-252
INT-254
INT-164
INT-253
9.39
INT-151
10.31
INT-250
INT-150
INT-59-P2
10.43
10.45
INT-26
INT-251
INT-165
10.79
INT-60-P3
10.53
INT-108
10.51
10.66
INT-127
INT-237
INT-238
INT-120
INT-123
10.56
10.48
INT-167
INT-168
INT-106
INT-236
INT-170
10.55
INT-153
10.44
INT-152
10.41
INT-154
10.35
INT-235
INT-239
INT-234
INT-169
INT-240
INT-155
8.18
INT-130
10.42
INT-130RS
10.40
FLTG-13
10.06
INT-256
10.15
INT-156
9.29
INT-257
10.05
INT-255
5.22
INT-258
5.55
5
6
7
8
9
10
9
LEGEND
S1 WELLS
SHEET PILE WALL
C1 CLAY ABSENT
10 POTENTIOMETRIC SURFACE (ft amsl)
10.42 GROUNDWATER ELEVATION (ft amsl)
8.78 SURFACE WATER ELEVATION (ft amsl)
INFERRED GROUNDWATER FLOW DIRECTION
400' 0 400'
SCALE IN FEET
Applied Hydrology Associates, Inc.
N
FLTG.,Inc.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 2-5
REGIONAL POTENTIOMETRIC SURFACE INT ZONE
DESIGN: MD
DATE: 11/26/02
DRAWING NUMBER
DRAWN: JLS
SCALE: AS SHOWN
Potentiometric Surface S1-INT.dwg
SCRIPT:

Both the East Slough and the East Pond are topographic low points and act as local S1 groundwater discharge areas, except when flood waters fill the ponds and adjacent floodplain to elevations above the South Pond. The East Slough is a shallow, natural oxbow feature, modified by road-side ditches along old Highway 90. The East Pond was an excavation testing the S1 sand resource, and was later a dumping ground for waste tires that have since been spread over the floodplain by floods. The East Pond was sounded January 2002, and found to be 16.5 feet deep, so that it certainly penetrates the top of the S1 sand horizon. Another beaver dam has raised the level of the East Pond, and flooded a wide marshy area. Both ponds have been used for illicit trash dumping over the years.

The significant (downward) potentiometric gradients between the paired INT and S1 wells located in Riverdale and west of the South Pond show that the C1 clay is continuous (no communication between S1 and INT) in these areas. In the vicinity of the windows in the C1 clay (where the S1 channels scour through the C1), the S1 and INT have approximately equal potentiometric head. The C1 windows could extend under some of the South Pond, as the heads in the S1 and INT are also similar in the area.

Groundwater flow directions, interpreted from potentiometric maps, correspond with the shapes of total VOC plumes for the S1 and the INT as discussed in Section 3. On the west side of the former lagoon there is no plume in the S1 as flow directions are toward the lagoon. INT west plumes extend in a southwesterly direction, following a flowpath similar to what should have existed prior to the sheet pile. On the east end of the sheet pile wall, parallel flows in S1 and INT are directed easterly parallel to the wall, toward the surface water ponds.

FIGURE 2-6
Hydrographs of East Slough, South Pond, and S1 Groundwater



3.0 SOURCE CHARACTERIZATION

3.1 Background

Groundwater monitoring has identified several areas of concern south of the former lagoon where groundwater is unlikely to meet compliance criteria at the end of the progress monitoring in 2005. These plume areas are shown above in Figure 1-2:

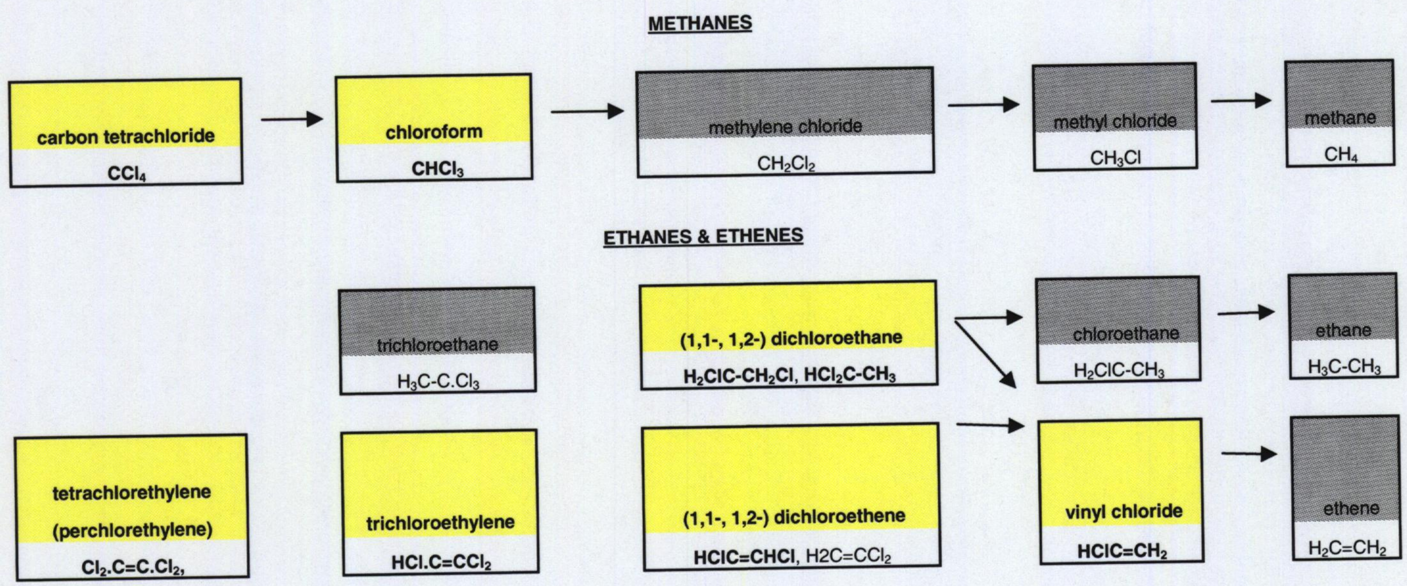
- A plume in the INT unit, containing benzene, 1,2 dichloroethane (1,2 DCA), and vinyl chloride (VC), extending southwesterly from the west end of the sheet pile enclosure to the INT-144 monitoring well. The 1,2 DCA and VC in the plume are detached from the sheet-pile wall and are now centered on INT-134, extending to INT-144. The benzene in this plume is localized around the INT-233 well.
- A benzene and vinyl chloride plume in the INT unit extending southwesterly from the west-central part of the sheet pile enclosure. The benzene in the plume has highest concentrations near the INT-26 well. Vinyl chloride occurs in the distel parts of the plume in the vicinity of the INT-252 and INT-217 monitoring wells.
- Overlapping plumes in the S1 and INT horizons in the east end of the site, centered on wells S1-123 and INT-130R. Over the last three years, chlorinated hydrocarbon concentrations have increased in S1-123 (completed in the S1), and held steady in INT-130R (completed in the INT unit).

The first two locations are confined to the INT unit and are referred to as the INT west plumes, while the third location includes both the S1 and INT units and is referred to as the S1-123 / INT-130R or east plumes area. Contaminant sources and fate and transport of COCs in each of these areas are characterized below to evaluate potential long-term risk posed to public health and the environment.

The main chemicals present in the areas of concern at concentrations above the French clean-up criteria are benzene, carbon tetrachloride (CT), 1,2-dichloroethane (1,2-DCA), 1,2-dichloroethene (1,2-DCE), vinyl chloride (VC), chloroform (CF), methylene chloride, acetone, 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), chloroethane, trichloroethylene (TCE), tetrachloroethylene (also known as perchlorethylene, or PCE), and 1,1,2,2-tetrachloroethane.

Chloroform, CT, 1,2-DCA, 1,2-DCE, 1,1-DCA, TCE, and PCE have previously been used as "signature compounds" in the east plumes. All of these key compounds belong to the degradation sequences described in Figure 3-1. TCE and PCE (both C=C ethenes) can produce both ethanes (C-C) and ethenes (C=C) with fewer chlorines. In Figure 3-1, chlorinated constituents highlighted in yellow are detected in significant concentrations in the current areas of investigation.

Figure 3-1
Degradation Sequences for Chlorinated Methanes, Ethanes and Ethenes



3.2 The West Plumes Area

INT west plume maps for vinyl chloride, 1,2-DCA and benzene, with histograms showing well concentrations through January, 2002 are provided in Figures 3-2, 3-3 and 3-4. These figures show the west plumes trending southwesterly, but with stationary or receding fronts. The vinyl chloride and 1,2-DCA plumes are detached from the lagoon, and attenuating at their upstream ends. The benzene plume emanating from the vicinity of well INT-233 just outside the sheet pile has been steadily shrinking, and there are currently no known off-site exceedences of the 5 μg/L MCL. Benzene concentrations in INT-233 are approximately steady, between 200 and 300 μg/L.

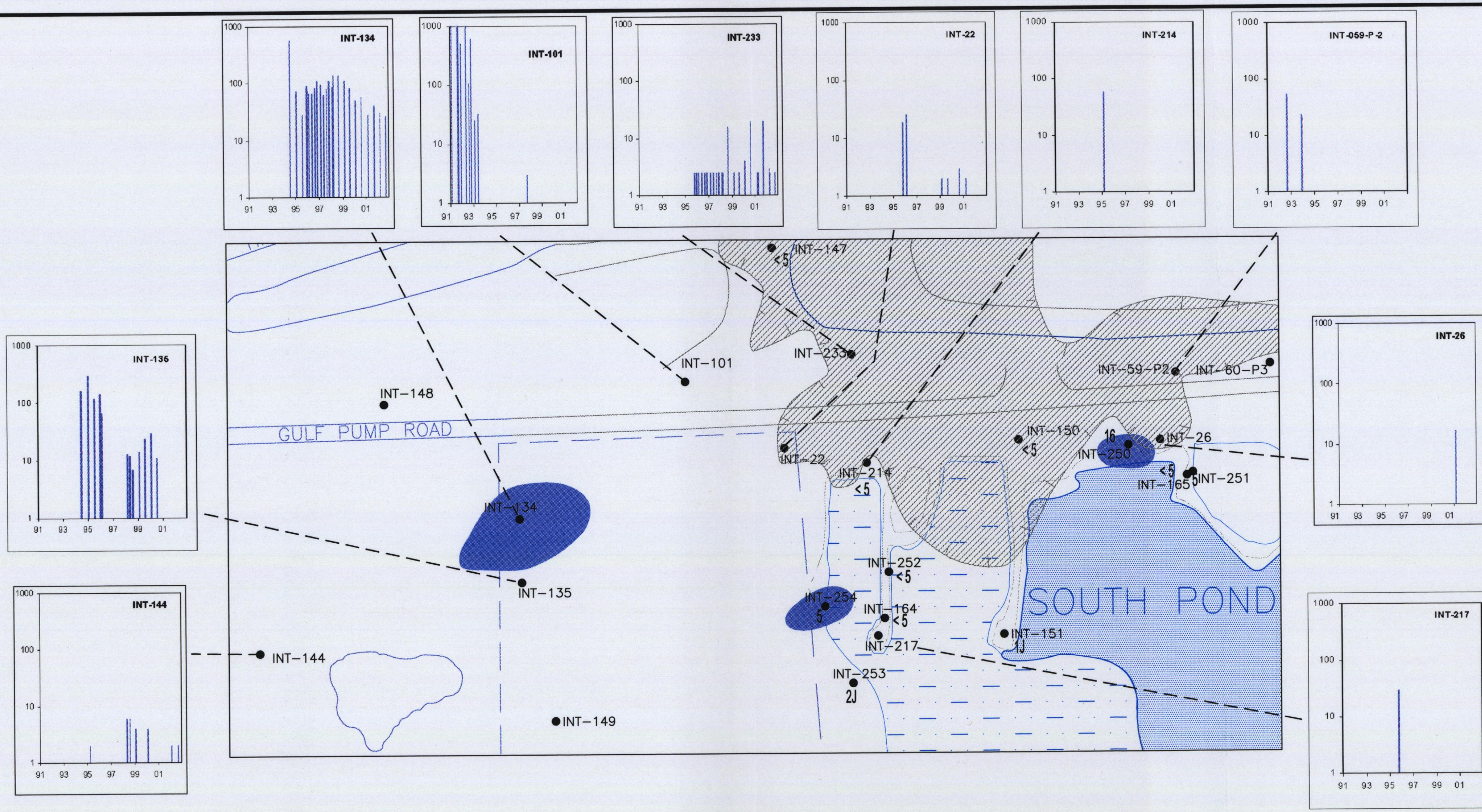
The VC and 1,2-DCA plume now centered on INT-134 has no apparent on-going source, but is migrating as a dilute solute plume, detached from its presumed original source near INT-233.

The fate of the INT west plumes was modeled assuming initial concentration distributions that existed at the end of active remediation (December 1995). These model results are reported in Section 4 and Appendix A.

3.3 The S1-123 / INT-130 Area

The S1-123 / INT-130R area, or the east plumes, is south of the former sand pit – lagoon and its enclosing sheet pile wall, between the former remedial office building and Gulf Pump Road. Chlorinated hydrocarbon concentrations have not declined as expected in several of the monitoring wells in this east end of the site, centered on wells S1-123 and INT-130R, completed in the S1 sand and INT interval, respectively. The risk posed by contaminants remaining in the S1-123/INT-130 area depends upon the nature of the contaminant source in this area and the fundamental hydrogeologic and contaminant fate and transport processes that transport and attenuate contaminants from this location to potential receptor locations.

A comprehensive DNAPL investigation was previously conducted near the southeast end of the lagoon to assess the possible occurrence of DNAPL outside the sheetpile wall. The work was performed in accordance with the *Remedial Investigation/Feasibility Study Work Plan for S1-16 and INT-11 DNAPL Areas* (March 1993) and the *Remedial Investigation/Feasibility Study Work Plan for S1-13 DNAPL Area* (April 1993). These Work Plans also described the site background and history, the groundwater and subsoil remediation system, indications of DNAPL occurrence, and results of previous DNAPL investigations.



LEGEND

- ● INT WELLS
- SHEET PILE WALL
- C1 CLAY ABSENT
- DCA >100 ug/l
- DCA >5 ug/l

150' 0 150'
SCALE IN FEET

N

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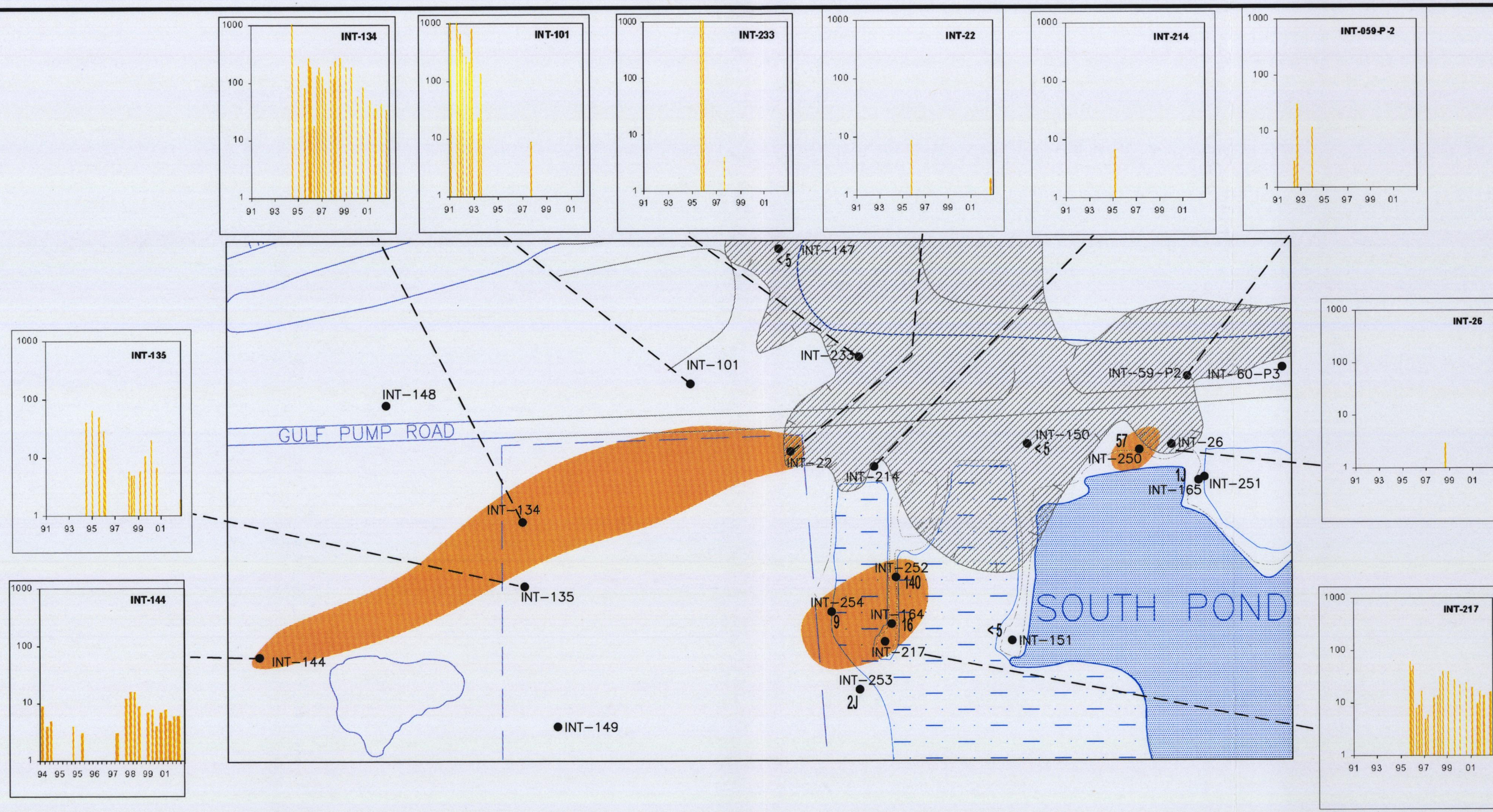
FIGURE 3-2
MONITORED 1,2-DCA CONCENTRATIONS IN TIME, WEST INT PLUMES

DESIGN: TWG	DATE: 1/10/02	DRAWING NUMBER
DRAWN: JLS	SCALE: AS SHOWN	FRENCH.DWG
SCRIPT:		



LEGEND

- INT WELLS
- SHEET PILE WALL
- C1 CLAY ABSENT
- VINYL CHLORIDE >100 ug/l
- VINYL CHLORIDE >2 ug/l

150' 0 150'
SCALE IN FEET

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N

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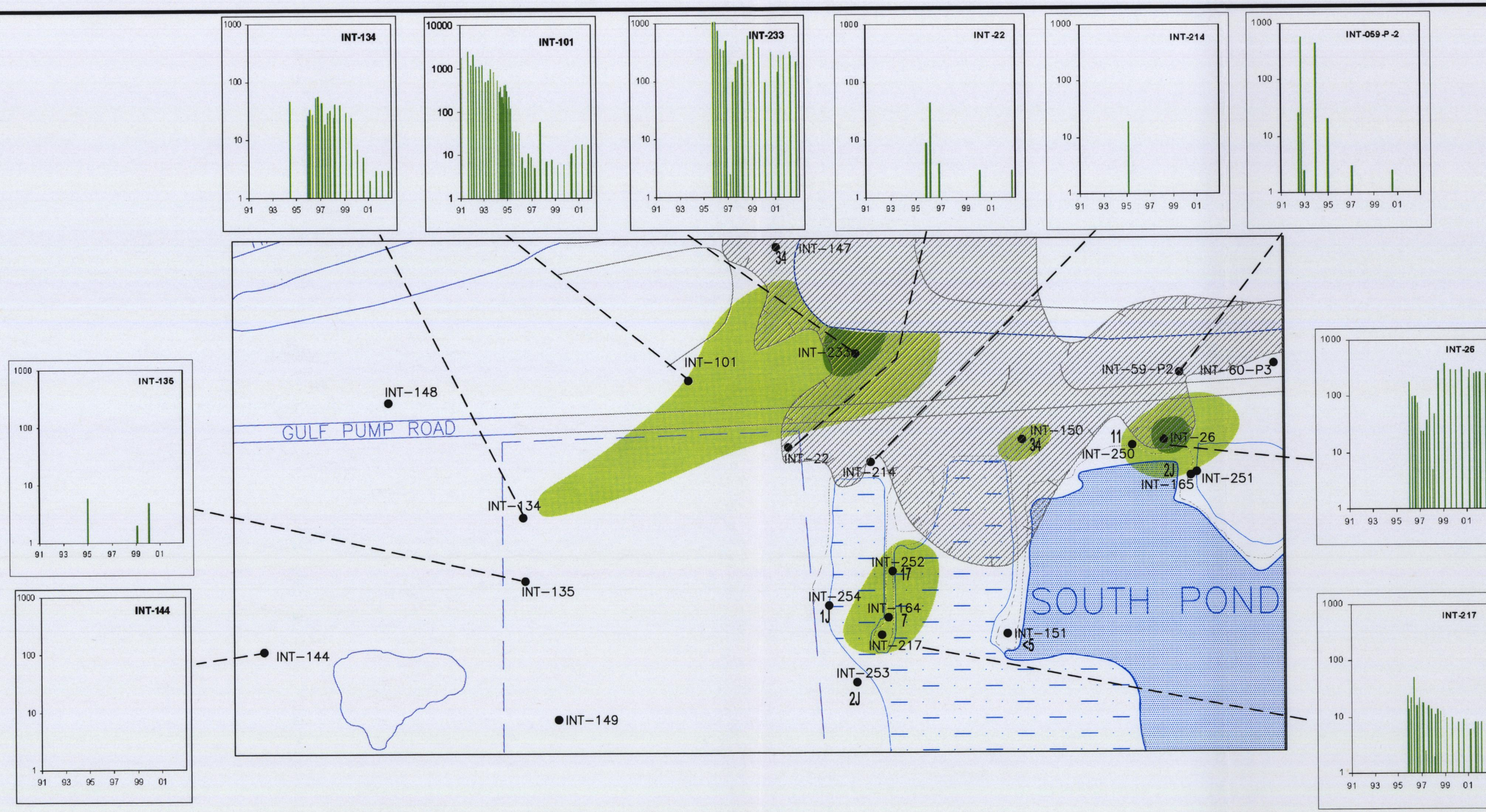
CROSBY, TEXAS

FIGURE 3-3
MONITORED VINYL CHLORIDE CONCENTRATIONS IN TIME, WEST INT PLUMES

DESIGN: TWG	DATE: 1/10/02	DRAWING NUMBER
DRAWN: JLS	SCALE: AS SHOWN	FRENCH.DWG
SCRIPT:		



LEGEND

- INT WELLS
- SHEET PILE WALL
- C1 CLAY ABSENT
- BENZENE >100 ug/l
- BENZENE >5 ug/l

150' 0 150'
SCALE IN FEET

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CROSBY, TEXAS

FIGURE 3-4
MONITORED BENZENE CONCENTRATION IN TIME, WEST INT PLUMES

DESIGN: TWG	DATE: 1/10/02	DRAWING NUMBER	
DRAWN: JLS	SCALE: AS SHOWN	FRENCH.DWG	
SCRIPT:			

The 1993 DNAPL investigation found no indications of DNAPL presence outside the original sheet-pile cutoff wall except in the INT-11 Area. In the INT-11 area, DNAPL was observed near the base of the INT (INT/C2 contact). There was no indication that DNAPL was continuing to migrate. Based on these results, a sheet-pile cutoff wall was installed to the base of the INT around the INT-11 area, and keyed to the original sheetpile, to contain the known presence of DNAPL in this location.

The sampling results for the S1 and INT are here discussed together, because they are superposed even though they may not be linked. The total volatile concentrations in both the INT and S1 in the east plumes area, and their monitoring history, are shown in Figure 3-5. Plume maps for benzene, 1,2-DCA and vinyl chloride follow as Figures 3-6 through 3-8. Since 2001, a number of new wells were installed to evaluate the plumes that did not appear to be attenuating as expected; histograms for these wells show four sampling periods. The fractions of individual chlorinated constituents making up the total VOC in most recent analyses are shown in pie charts on Figures 3-9 and 3-10.

Total volatile concentrations have risen since 1995 in well S1-123. New S1 wells in this vicinity show a narrow tongue of high concentrations extending easterly through S1-123, S1-151, S1-155, and S1-149. All these wells except S1-123 were installed in 2001, so that the extent of the high concentration plume has only recently been delineated and confirmed by four sampling periods.

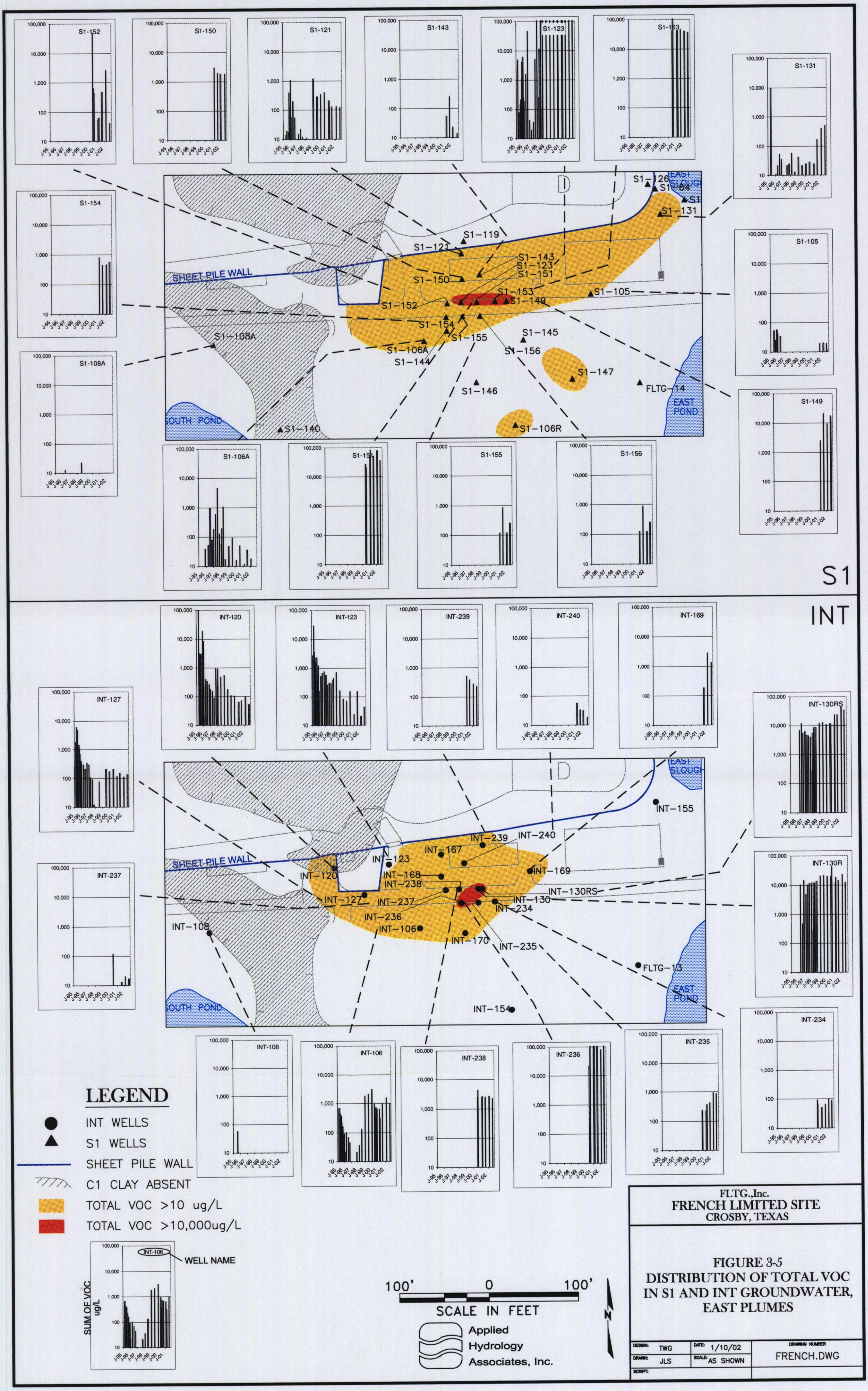
Concentrations in the core of the S1 plume (where total VOC > 10,000 ug/L) appear to be approximately steady. Total VOC concentrations in S1-123 have been between 100,000 and 200,000 ug/L since 1997. The total VOC concentration in downgradient well S1-149 is approximately 19,000 ug/L. The total VOC concentrations in S1-131, 50 feet from the East Slough, vinyl chloride has risen to 390 µg/L. The S1-131 well may indicate at the leading edge of the plume, but it also could be sourced more locally.

VOC concentrations have declined in most S1 wells outside of the high concentration core, that is, by and large the impacted area is shrinking laterally. The core of the S1 plume appears, however, to be sustained by an ongoing source upgradient of S1-123, with a signature dominated by DCA, DCE and CF.

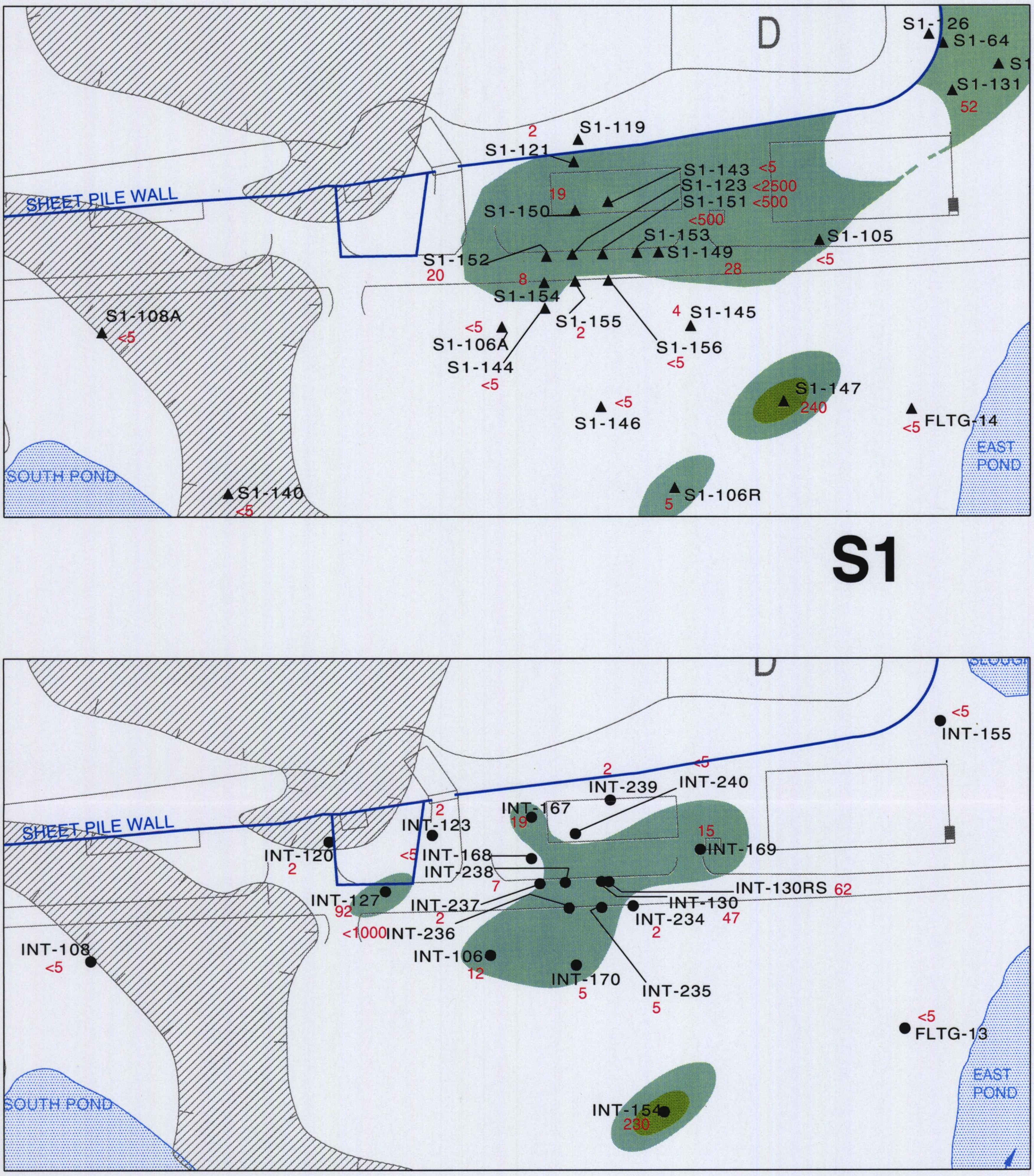
In the INT, chlorinated VOCs have remained at high concentrations in wells INT-130RS and INT-130R. Both these wells are adjacent to S1-123. The INT-130RS well is screened at the top of the INT unit, and INT-130R well is screened at the base of the INT. The INT-130R water contains significant PCE and CT while the INT-130RS shows a composition that is intermediate between the INT-130R water and the overlying S1-123 water, which is dominated by DCA, DCE and CF.

Additional INT wells installed in 2001 have permitted the definition of a high concentration VOC plume extending from INT-236 and INT-235, on the south side of Gulf Pump Road, through INT-130R toward the east northeast past well INT-169. Well INT-235 shows high proportions of PCE and CCl_4, like INT-130R. This INT plume appears to originate south of or under Gulf Pump Road, and trends slightly obliquely to that in the S1.

Pie plots have been developed below to show the relative concentration of signature compounds observed in these monitoring wells. Figure 3-6 shows the relative concentrations of chlorinated methanes (C-1 compounds carbon tetrachloride or CT, chloroform or CF, and methylene chloride) groundwater at monitoring wells in both the INT and the S1, while Figure 3-7 shows the relative composition of chlorinated ethanes and ethenes (C-2s). Figure 3-6 shows that the relative concentration for carbon tetrachloride is much higher at wells INT-130R and INT-235 than in other nearby wells. The pie charts of Figures 3-6 and 3-7 suggest distinct, small residual sources in the S1 upgradient of well S1-123 (small fractions of PCE and CCl_4), and in the INT upgradient of INT-130R (higher fractions of PCE and CCl_4). Fractionation along the plumes by differing solubilities and degradation rates obscures the differences in source compositions downgradient of the apparent source areas. The pie charts clearly show this progression to less chlorinated compounds along both S1 and INT plume flow paths.



S1-152
S1-150
S1-121
S1-143
S1-123
S1-153
S1-131
S1-154
S1-105
S1-108A
S1-149
S1-106A
S1-151
S1-155
S1-156
SHEET PILE WALL
EAST SLOUGH
EAST POND
SOUTH POND
S1-126
S1-64
S1-119
S1-145
S1-144
S1-146
S1-147
S1-106R
S1-140
FLTG-14
S1
INT
INT-120
INT-123
INT-239
INT-240
INT-169
INT-127
INT-130RS
INT-237
INT-130R
INT-234
INT-108
INT-106
INT-238
INT-236
INT-235
INT-155
INT-167
INT-168
INT-130
INT-170
INT-154
FLTG-13
LEGEND
INT WELLS
S1 WELLS
SHEET PILE WALL
C1 CLAY ABSENT
TOTAL VOC >10 ug/L
TOTAL VOC >10,000ug/L
WELL NAME
SUM OF VOC ug/L
100' 0 100'
SCALE IN FEET
Applied Hydrology Associates, Inc.
FLTG.,Inc.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE 3-5
DISTRIBUTION OF TOTAL VOC IN S1 AND INT GROUNDWATER, EAST PLUMES
DESIGN: TWG
DATE: 1/10/02
DRAWN: JLS
SCALE: AS SHOWN
DRAWING NUMBER
FRENCH.DWG



LEGEND

- ● INT WELLS
- ▲ S1 WELLS
- SHEET PILE WALL
- C1 CLAY ABSENT
- BENZENE >1,000 ug/L
- BENZENE >100 ug/L
- BENZENE >5 ug/L

100' 0 100'

SCALE IN FEET

N

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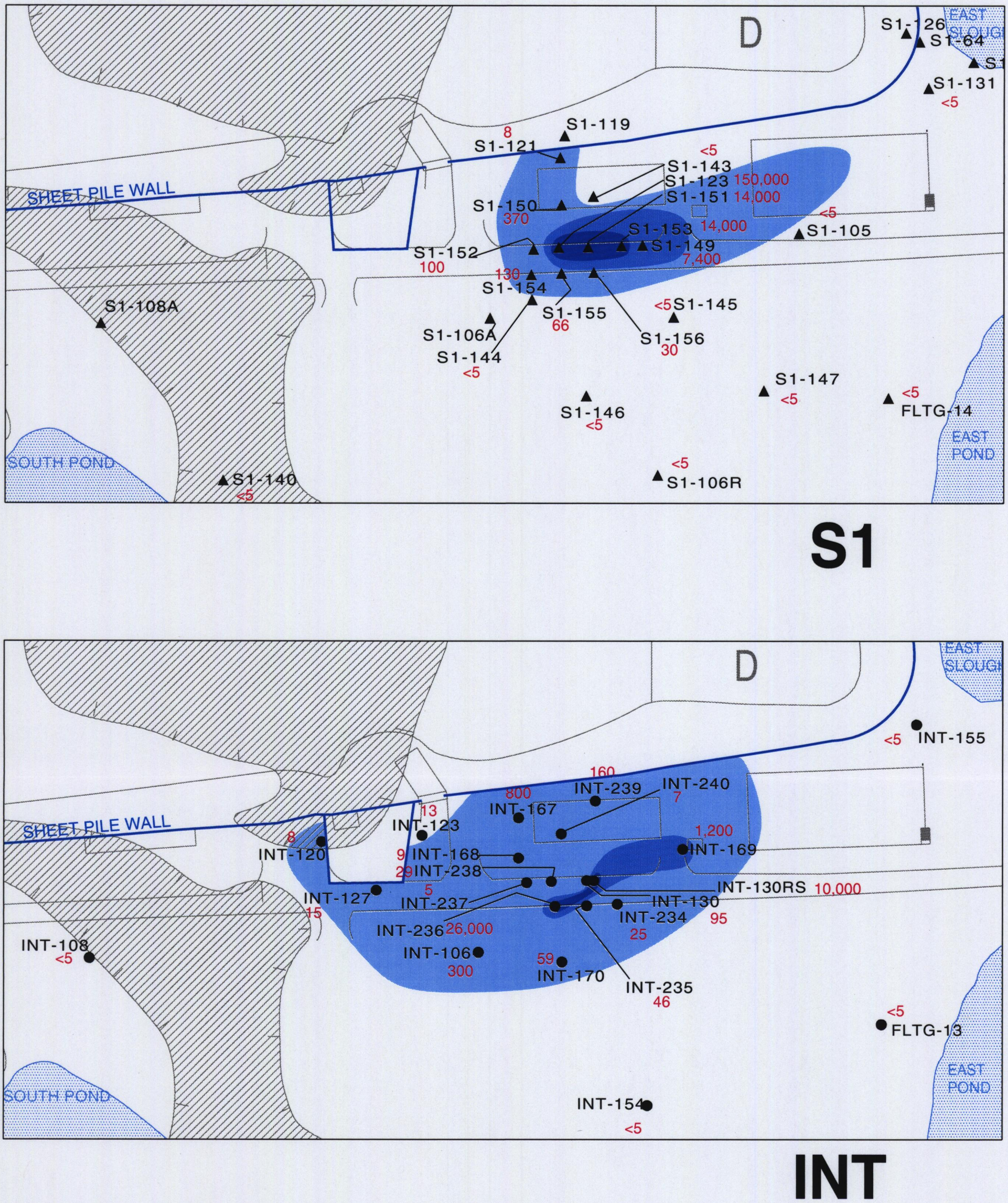
FIGURE 3-6
DISTRIBUTION OF BENZENE IN S1 AND INT GROUNDWATER, EAST PLUMES

DESIGN: TWG	DATE: 1/10/02	DRAWING NUMBER	FRENCH.DWG
DRAWN: JLS	SCALE: AS SHOWN		
SCRIPT:			



LEGEND

- ● INT WELLS
- ▲ S1 WELLS
- SHEET PILE WALL
- C1 CLAY ABSENT
- 1,2 DCA >10,000 ug/L
- 1,2 DCA >1,000 ug/L
- 1,2 DCA >5 ug/L

100' 0 100'

SCALE IN FEET

N

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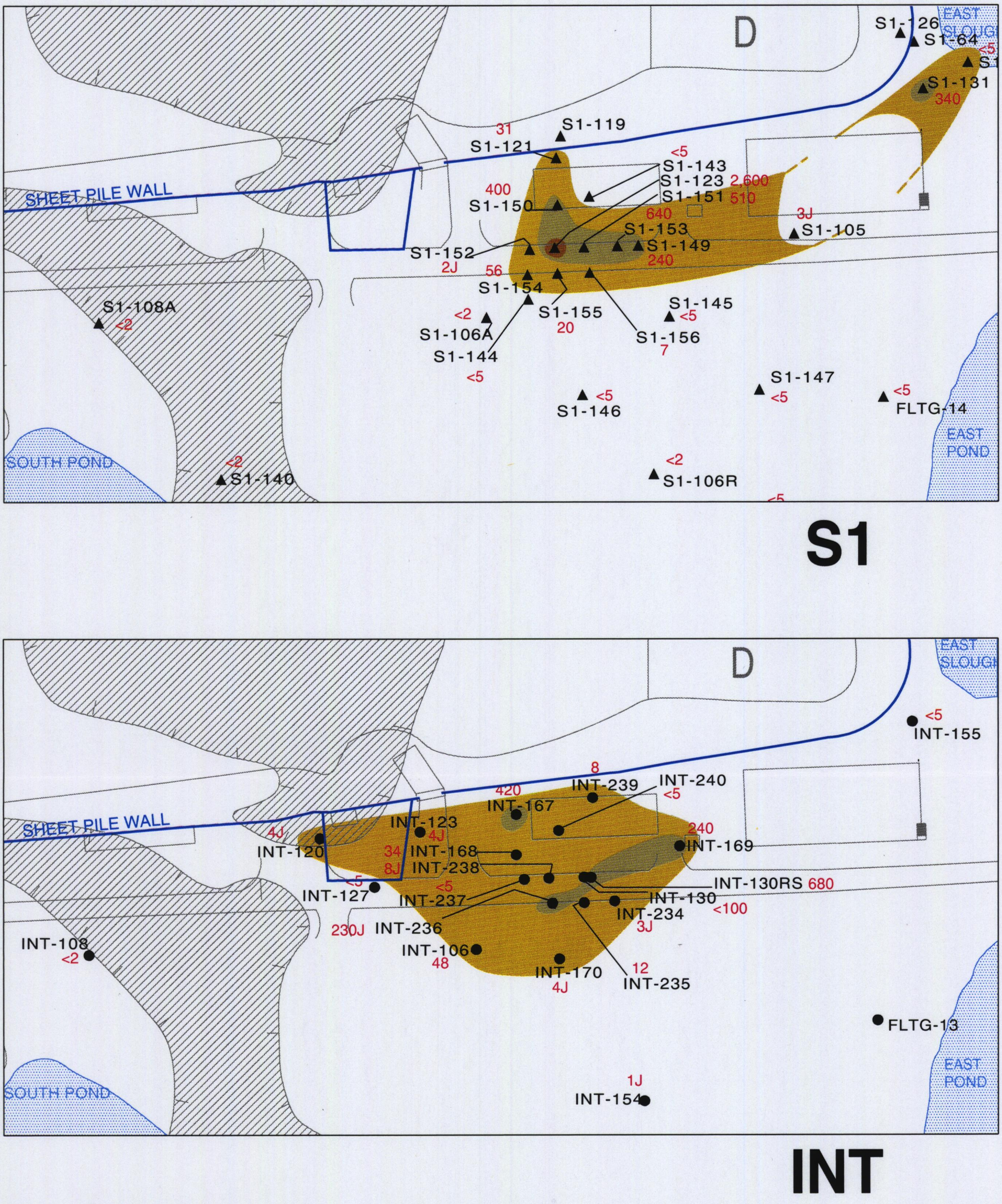
CROSBY, TEXAS

FIGURE 3-7
DISTRIBUTION OF 1,2-DCA IN S1 AND INT GROUNDWATER, EAST PLUMES

DESIGN: TWG	DATE: 1/10/02	DRAWING NUMBER FRENCH.DWG
DRAWN: JLS	SCALE: AS SHOWN	
SCRIPT:		



LEGEND

- ● INT WELLS
- ▲ S1 WELLS
- SHEET PILE WALL
- C1 CLAY ABSENT
- VINYL CHLORIDE >1,000 ug/L
- VINYL CHLORIDE >100 ug/L
- VINYL CHLORIDE >5 ug/L

100' 0 100'

SCALE IN FEET

N

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FIGURE 3-8
DISTRIBUTION OF VINYL CHLORIDE IN S1 AND INT GROUNDWATER, EAST PLUMES

DESIGN: TWG	DATE: 1/10/02	DRAWING NUMBER FRENCH.DWG
DRAWN: JLS	SCALE: AS SHOWN	
SCRIPT:		

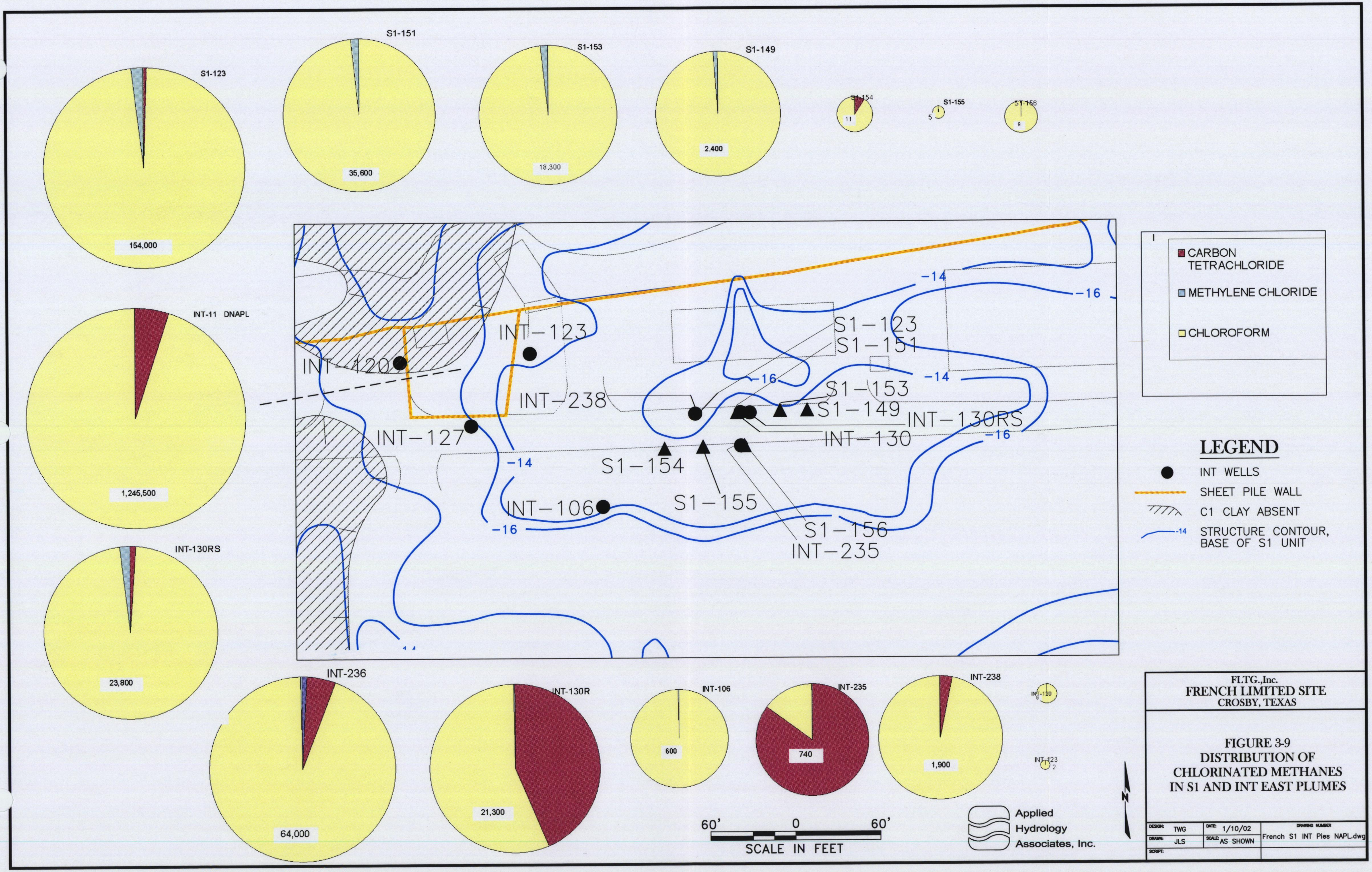

FIGURE 3-9
DISTRIBUTION OF CHLORINATED METHANES IN S1 AND INT EAST PLUMES

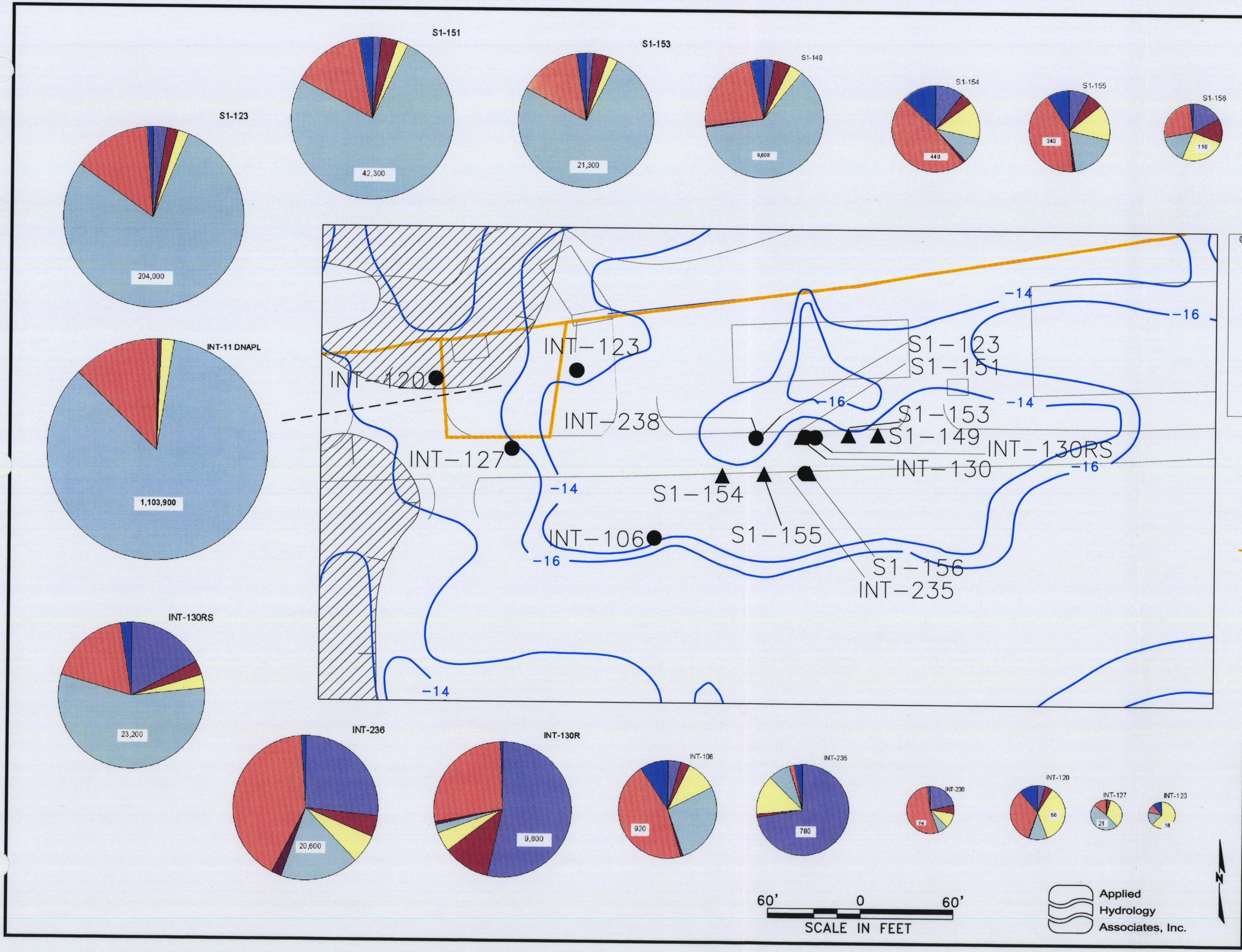

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FIGURE 3-10
DISTRIBUTION OF CHLORINATED ETHENES AND ETHANES IN S1 AND INT EAST PLUMES

DESIGN: TWG	DATE: 1/10/02	DRAWING NUMBER	
DRAWN: JLS	SCALE: AS SHOWN	French S1 INT Pies NAPL.dwg	
SCRIPT:			

4.0 FATE AND TRANSPORT

In this section the migration and attenuation of the plumes of concern is described by reference to monitoring data and modeling projections of fate and transport processes. These determine future potential exposure pathways, whose risk is evaluated in Appendix D and summarized in Section 5.

Monitoring data is currently reported semi-annually, based on sampling wells remaining after post-remedial abandonment of a once dense network of wells. Plumes were originally well defined by the more numerous wells, and the retained wells were thought sufficient to monitor migration of those plumes. A number of new wells were installed in 2001 in response to unexpected increases in concentrations in several wells in the east area, and to perceptions that the west INT plumes were not attenuating as fast as expected.

Some of the new wells were not logged, and anecdotal reports by drillers that the C1 clay appeared to be missing were reflected in tentative re-drawing of the C1 window. Because of the importance of this question with regard to fate and transport considerations in groundwater and evaluation of potential remedial response measures, a cone penetrometer survey was conducted in 2002. It was found that the C1 in fact appears to be continuous over the area of concern in the S1-123 / INT-130R area. The C1 window has been redrawn on maps in this report, which differ on this account from some maps presented earlier.

4.1 West INT Plumes

The west INT plumes extend southwesterly from former source areas in the lagoon. There are no corresponding plumes in the S1, because S1 groundwater flow in this area is to the northeast toward the French Lagoon.

Since active remediation ceased at the end of 1995, monitoring in the west INT area has shown declines in the concentrations of benzene, 1,2-DCA and vinyl chloride, and downgradient wells show that the fronts of the plumes are stationary or receding. Historical trends in concentrations are shown in histograms in Figures 3-2 through 3-4 in the previous section. Despite the decline in concentrations observed in the INT west area, it is unlikely that all the constituents will attain the compliance criteria in all wells by the end of the progress monitoring in 2005.

The intuitive inference that the concentration of vinyl chloride has been declining since 1997 at the leading edge of the INT west VC – DCA plume (at INT-144) can be assessed by non-parametric statistics. The Mann-Kendall test, favored by Wilson[5] at EPA, Ada, OK, amongst others, for establishing objectively whether variable monitoring data constitute an overall decreasing trend. The test counts consecutive increases and decreases, sums these counts to give a test statistic, and gives a confidence level that the trend is actually decreasing based on the number of values and the test statistic count. This test is reported more fully in Appendix C. The results of the test with 1997 through 2002 data at INT-144 are that vinyl chloride is attenuating (concentrations are decreasing) in time, with 90% confidence.

For this evaluation, simple one-dimensional groundwater transport modeling along plume centerlines was performed to assess the migration and attenuation of the INT west plumes. Model center lines are shown on a benzene plume map in Figure 4-1. Visual MODFLOW was used for flow modeling and MT3DMS for mass transport and attenuation. Degradation in the MT3DMS code was modeled using first order decay constants.

The groundwater flow was modeled for the west plumes centerlines, by setting constant head nodes consistent with observed potentiometic heads at the upgradient and downgradient boundaries of each plume model. This approximates recharge of the INT through C1 windows south of the lagoon with groundwater flow to the southwest or down the San Jacinto valley.

Concentration distributions of benzene, 1,2-DCA and vinyl chloride at the end of active remediation (December, 1995) were estimated using post-remediation monitoring data for this time. These concentrations distributions were used as a starting point for the model initial conditions. Adjustments to these initial conditions, in areas where no monitoring well control was available, was performed during model calibration.

The monitoring data from the wells in the west INT plumes for the period 1996 through 2002 were used to calibrate the models. Hydraulic and mass transport parameters, and first-order decay constants, were initially estimated from literature values, limited field data, and previous BIOTRANS modeling. Calibration to existing data resulted in refinement of transport parameters and degradation rates to match actual observed concentration trends.

The models were then used to project future concentrations within the INT West plumes. The model results are presented in Appendix A. Model simulation times were extended sufficiently for the plumes to attenuate to standards everywhere within compliance boundary. Graphs of the centerline concentrations through time at selected observation points in the INT-101/134/144 plume are shown below as Figures 4-2 through 4-4.

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[5] E.g. Barbara Wilson and John Wilson. Techniques to Extract Rate Constants for Natural Attenuation. A short course given at many US venues in 2001, 2002.
References to the Mann-Kendall method can be found in any non-parametric statistics compilation, eg Press et al, 1986. Numerical Recipes, Cambridge Uni. Press.

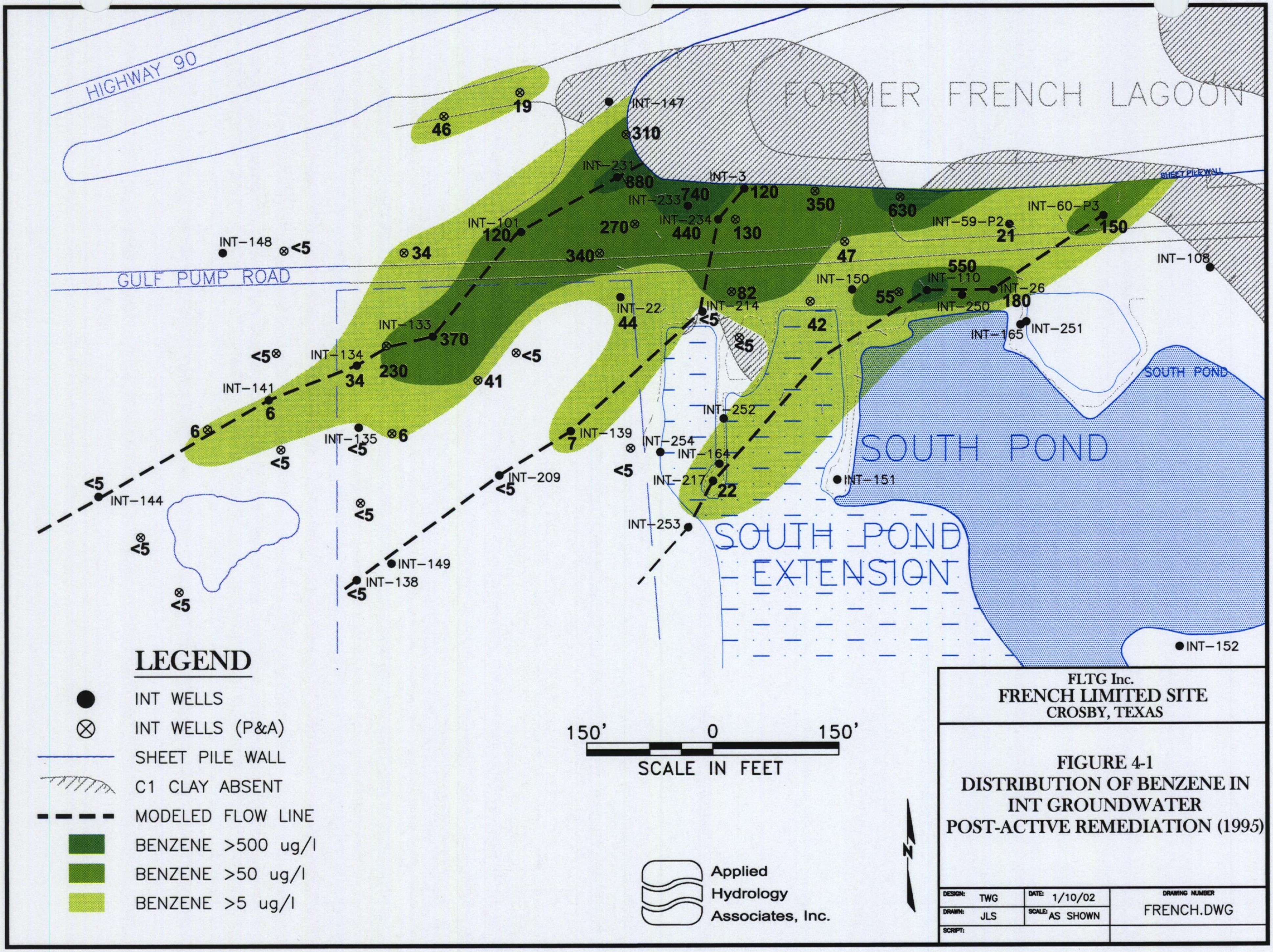


FIGURE 4-1
DISTRIBUTION OF BENZENE IN INT GROUNDWATER POST-ACTIVE REMEDIATION (1995)

The model-predicted times to achieve standards through natural attenuation in the west INT area are:

vinyl chloride	1,2-DCA	benzene
20 years (2017)	22 years (2018)	19 years (2015)

The model predicts, based on assumed first order degradation and calibration over a seven-year monitoring period (1996 – 2002), that the west INT plumes will not migrate past their present positions, that they will shrink steadily, and that drinking water standards will be met everywhere by 2018. The lack of migration is in accord with monitoring at the downgradient wells in these plumes, seen above in Figures 3-2through 3-4.

Initial first order decay constants were used from literature, and then adjusted to calibrate the model. The final decay constants were:

COC	k /day	k /yr
Benzene	0.02	7.3
1,2-DCA	0.002	0.73
Vinyl chloride	0.003	1.01

The INT west plumes currently fail drinking water standards off site, and the model predicts that they will continue to do so until about 2018, when they will have naturally attenuated to less than the standards. The model and the monitoring data predict that the plumes will not migrate off property with institutional controls, and so will not cause an exceedence of any standard at any point of actual off-site exposure. That is, the west plumes are currently not expected to achieve compliance by 2006 as specified in the ROD, but will achieve compliance by natural attenuation within the next 15 years (by 2018).

4.2 S1 at S1-123

A history of concentrations of chlorinated hydrocarbons in S1 groundwater at the S1-123 area, and the proportions of these constituents, are shown above in Section 3. A residual source of chlorinated compounds is indicated in Section 3 to be located somewhere between well S1-123 and the INT-11 sheetpile containment wall (Section 3). New S1 wells in this vicinity show a narrow tongue of high concentrations extending easterly through wells S1-123, S1-151, S1-155, and S1-149, toward the East Slough. Concentrations in the core of the S1 plume appear to be approximately steady, with total VOC in S1-123 between 100,000 and 200,000 ug/L since 1997. The total VOC concentration in downgradient well S1-149 is approximately 19,000 ug/L.

Figure 4-2 - Modeled vs observed concentrations at INT-101 monitoring well

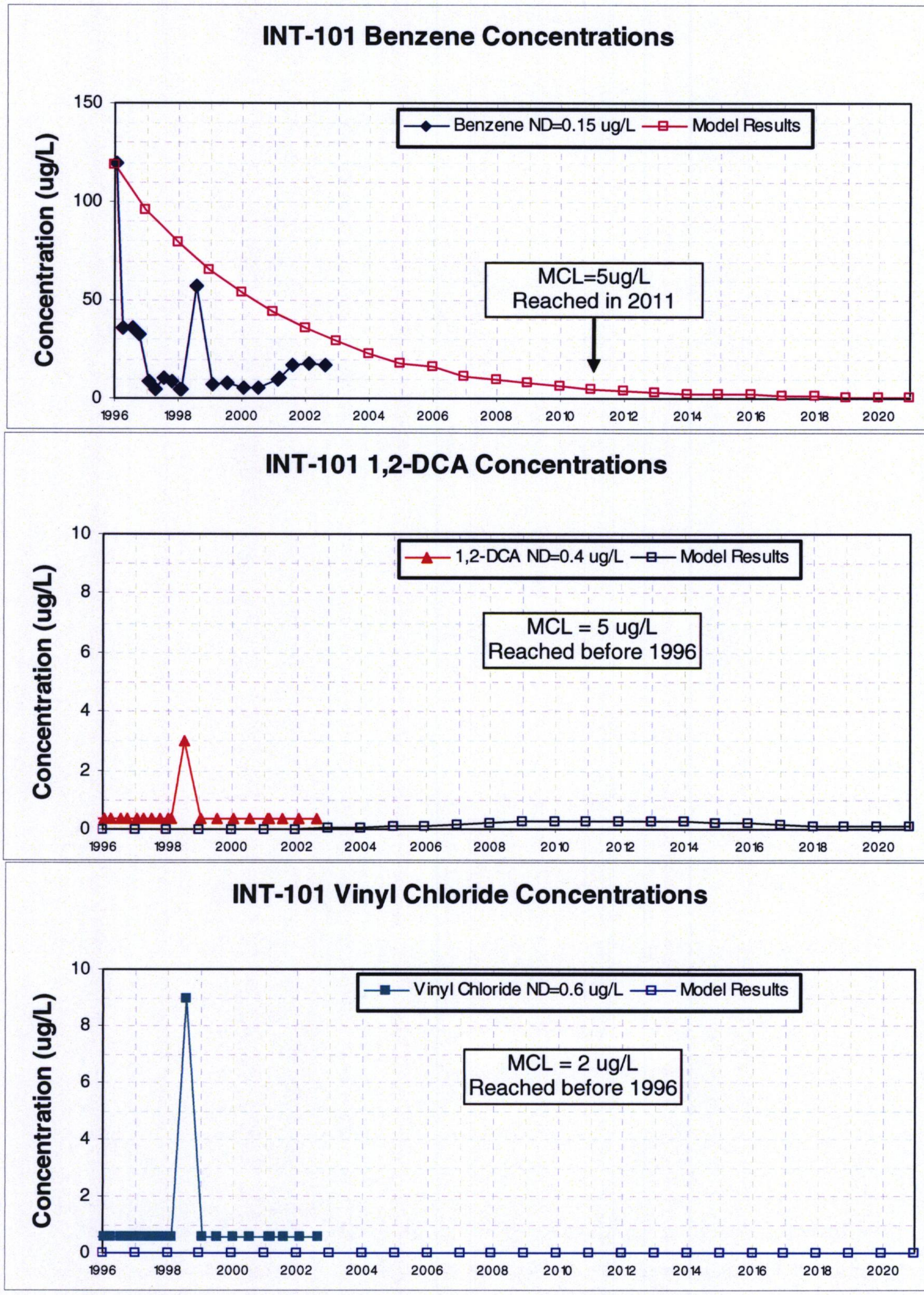


Figure 4-3 - Modeled vs observed concentrations at INT-134 monitoring well

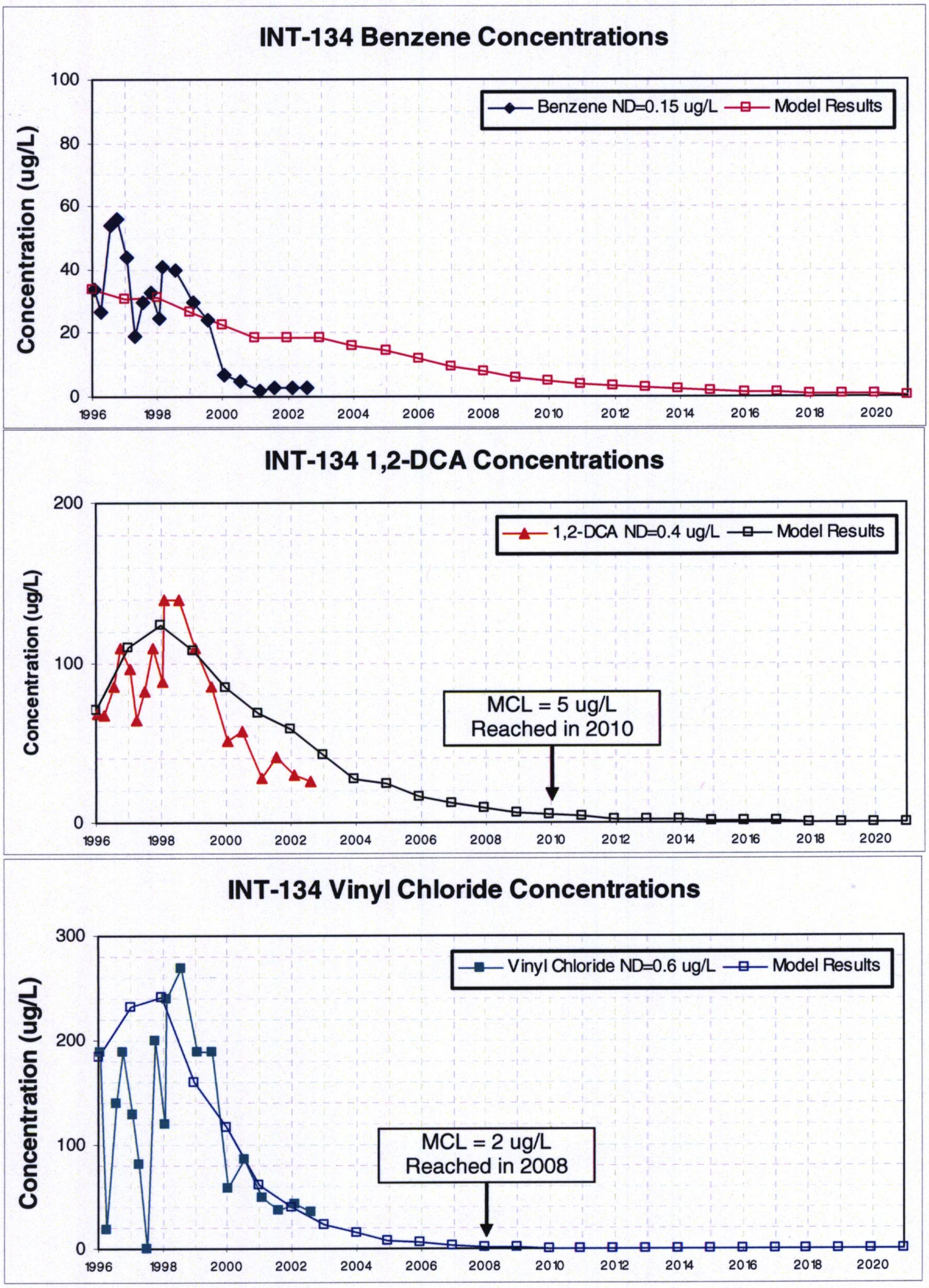
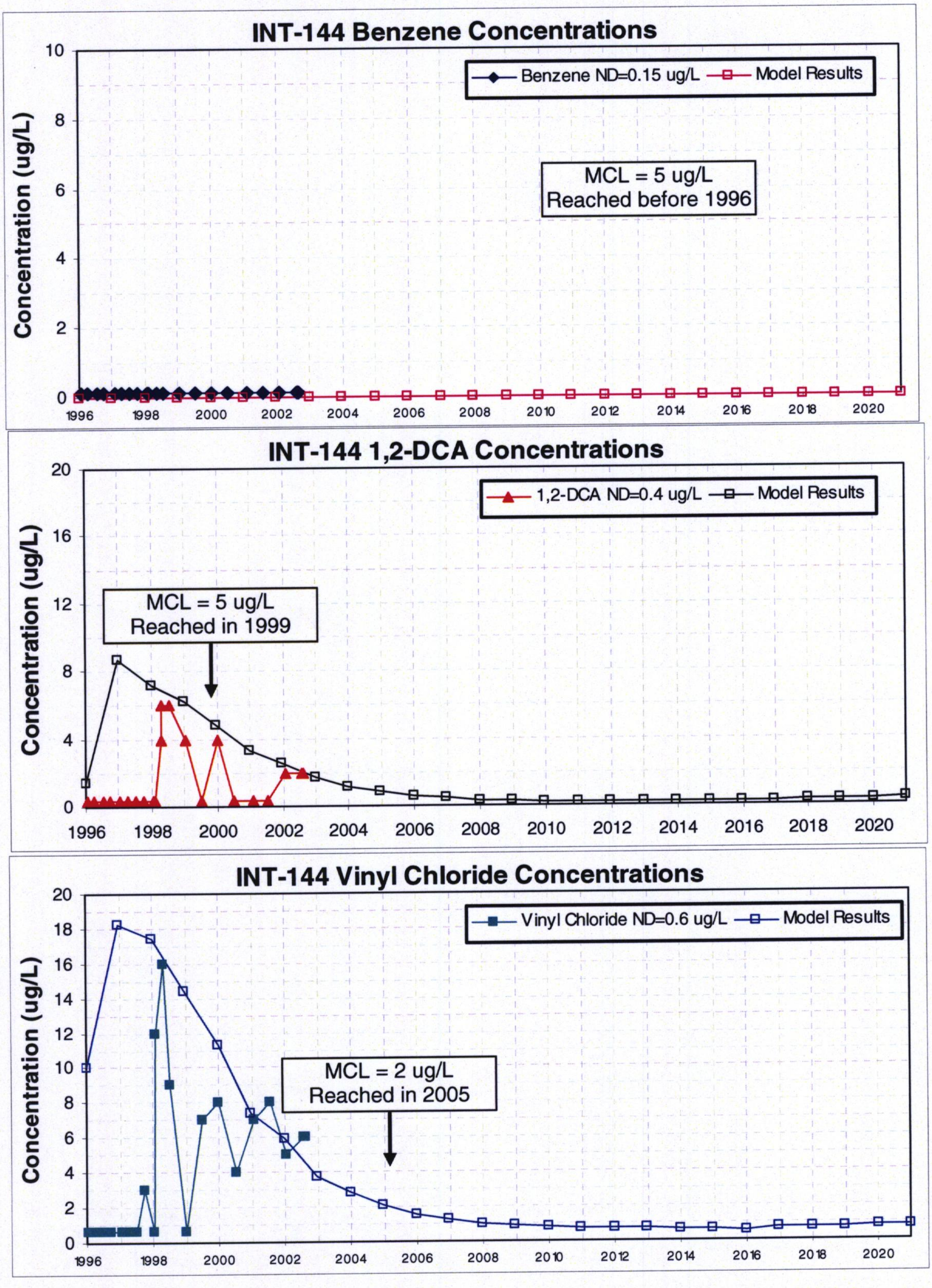


Figure 4-4 - Modeled vs observed concentrations at INT-144 monitoring well



VOC concentrations have declined in most S1 wells on the flanks of the plume, indicating that the impacted area is shrinking laterally. The core of the plume appears, however, to be sustained by an ongoing source, and the leading edge of the plume appears to be approaching the East Slough. Concentrations of PCE, 1,2-DCA and chloroform exceed 1% of their pure solubilities in well S1-123, suggesting the possible nearby presence of NAPL residual.

The S1-123 plume has high concentrations of DCA and DCE near its source, but due to different rates of retardation and degradation for the various species, vinyl chloride and 1,2-DCA dominate the leading edge. Similar evolution along the INT plume leads to a similar composition at the front, despite the differing source composition. Vinyl chloride tends to accumulate as a product of degradation of more chlorinated species. It is readily degradable under aerobic conditions, but is slower to degrade under anaerobic conditions believed to exist in the plume cores.

The spreadsheet code BIOCHLOR was used to predict COC concentrations at off-site points of compliance. Three points off French property, and not currently under any form of institutional control, were identified as possible "point of exposure" or POE wells; these are shown in Figure 5-1 in Section 5. All three are in floodplain marsh land, the actual probability of wells at these points is negligible even without institutional controls, and French is pursuing deed restrictions on the property where POE-1 and POE-2 lie. Thus, there is no current risk at POE-1 or POE-2, and modeled future risk at these points will be obviated by institutional controls. Modeled concentrations at POE-1 and POE-2 are, however, reported below to assess concentrations of COCs in the S1 likely to impact the ponds (POE-1), to illustrate the attenuation of those chemicals along a migration path, and to show the need for the proposed property controls.

POE Well *	**Location**	**Tract Number**	**Distance (ft) from S1-123**
(1)	South of Gulf Pump Road, east of East Pond	7	325
(2)	North of Gulf Pump Road, east of French		520
3	Southwest of East Pond	4	1,000

* POE-1 and POE-2 hypothetical well locations to be placed under institutional control

Table 4-1 summarizes the predicted concentrations of chlorinated compounds at the three POE wells. Tables summarizing input and output data are found in Appendix B. Files for BIOCHLOR runs are also found on the CD in Appendix B. Input for the BIOCHLOR runs in the S1 were:

Hydraulic conductivity K=0.01 cm/sec (28 ft/day) from S1-123 to POE 1,2, and 3
Porosity n=0.3
Hydraulic gradient i=0.002
[=> Seepage velocity, v =69 ft/year (v = Ki/n)]
*f*oc=0.004
Constant strength source at S1-123 with COC concentration = {mean + 2 x std devn} in data since 1999

BIOCHLOR modeling using constant strength sources at S1-123 predicts detectable concentrations in the S1 at POE 1 and POE 2 locations, of PCE, TCE, DCE vinyl chloride and DCA in excess of MCLs. No detections are predicted of any chlorinated constituents at POE 3 (the predicted concentrations are less than the method detection limits).

4.3 INT at INT-130R

It is indicated above in Section 3 that there is likely a residual source in the INT near INT-236, on the south side of Gulf Pump Road. INT-235 and INT-130R both show relatively high PCE and CT fractions, suggesting a different source composition than seen in nearby S1 wells, although the S1 and INT plumes have similar chemistry in their downgradient reaches. PCE exceeds 1% of its pure solubility in wells INT-236, -130R and -130RS in August 2002 samples. Well INT-130RS, screened in the upper part of the INT, shows a composition that is intermediate between that of S1-123 solute (high DCA) and INT-130R solute.

CT and CF dominate the INT East plume extending from INT-130R. The transport and attenuation of chloroform, the latter the most mobile VOC in the INT east plume, was modeled by BIOCHLOR. The three hypothetical "POE"supply well locations defined above were also used to assess the exposure of the INT East plume.

Concentrations of VOCs have declined in INT wells adjacent to the INT-11 sheetpile wall, showing that isolation of this former source area has allowed rapid attenuation of originally high concentrations. The persistence of elevated but stable concentrations of PCE and CT at INT-130R, however, suggests a distinct residual source, which may sustain release of dissolved chlorinated hydrocarbons for some time.

Table 4-1
BIOCHLOR Predicted Concentrations at POE Locations, East Plumes

S1

	Concentrations, µg/L						
	S1-123	POE 1 x = 325 ft		POE 2 x = 520 ft		POE 3 x = 1,000 ft	
COC	***2003***	***2010***	***2050***	***2010***	***2050***	***2010***	***2050***
CT	3,000	< 1	< 1	< 1	< 1	< 1	< 1
CF	283,000	< 1	< 1	< 1	< 1	< 1	< 1
PCE	9,600	**300**	**300**	**30**	**40**	< 1	< 1
TCE	8,000	**900**	**900**	**90**	**150**	< 1	**1**
DCE	41,000	**280**	**280**	**30**	**40**	< 1	< 1
VC	4,100	**290**	**290**	**30**	**350**	< 1	< 1
TCA	200	**20**	**20**	**1**	**1**	< 1	< 1
DCA	330,000	**20,000**	**15,000**	**400**	**600**	< 1	< 1

INT

	Concentrations, µg/L						
	INT-130R	POE 1 x = 325 ft		POE 2 x = 520 ft		POE 3 x = 1,000 ft	
COC	***2003***	***2010***	***2050***	***2010***	***2050***	***2010***	***2050***
CT	19,700	< 1	< 1	< 1	< 1	< 1	< 1
CF	17,500	< 1	< 1	< 1	< 1	< 1	< 1
PCE	21,000	< 1	< 1	< 1	< 1	< 1	< 1
TCE	2,000	< 1	**3**	< 1	< 1	< 1	< 1
DCE	4,200	< 1	**1**	< 1	< 1	< 1	< 1
VC	950	< 1	**1**	< 1	< 1	< 1	< 1
TCA	200	< 1	< 1	< 1	< 1	< 1	< 1
DCA	15,800	< 1	**1**	< 1	< 1	< 1	< 1

CT = carbon tetrachloride; CF = chloroform; PCE = perchlorethylene; TCE = trichloroethylene; VC = vinyl chloride; TCA = 1,1, 1-trichloroethene;
DCE = sum of *cis* 1,2-, *trans* 1,2-, 1,1-DCE. properties as for *cis* 1,2-DCE (highest conc); DCA = 1,1- and 1,2-DCA, properties for 1,2-DCA
TCA reported concentrations generally non-detect with high PQL ; 0.2 mg/L at source ~ 2 x average PQL

Plumes migrate slower in the INT than in the S1 because of lower hydraulic conductivity and higher native carbon and fines content in the INT. The retardation was higher in the INT by virtue of a high *effective foc* (6 %), which was arrived at in calibrating INT west plume transport. This value is reasonable in accounting for the interbedded silts and clays of the INT, which have a large capacity for diffusion, clay face adsorption and low permeability storage.

COC fate and transport in the INT east plume was modeled by BIOCHLOR; results are given above in Table 4-1. Degradation rates for aerobic and anaerobic zones were taken from literature reports, and geometric means of high and low values for each COC were used for initial values in BIOCHLOR. These values were found to satisfactorily calibrate INT west plume transport and attenuation, and so were not altered.

Input for the BIOCHLOR runs in the INT were:

Hydraulic conductivity K=0.001 cm/sec (2.8 ft/day)
Porosity n=0.3
Hydraulic gradient i=0.005
[=> Seepage velocity v =17 ft/year (v = Ki/n)]
*f*oc=0.06 (equivalent to 6% native carbon, but actually representing retardation by finer grained units)
Constant strength source at INT-130R of {mean since 1999 + 2 x std dev}

No chlorinated compounds are predicted by BIOCHLOR, using the assumptions noted, to be detectable at concentrations greater than the MDLs or MCLs, in INT groundwater at any of the POE wells, through 2050. Some low concentrations (1 µg/L to 3 µg/L) are predicted at POE 1, but these are less than MCLs. The POE locations are not realistic exposure points. As noted above, institutional controls are being sought for POE-1 and POE-2 locations.

4.4 Surface Water

S1 groundwater appears in part to discharge to the East Slough and possibly the East Pond. Predicting the concentrations of constituents in pond water is necessary for estimation of exposure risk posed by the ponds. This section assesses the likely pond COC concentrations, based on S1 concentrations predicted in S1 groundwater at POE 1 (developed above in Section 4-2), and currently observed attenuation of those concentrations from groundwater to receiving pond water. Concentrations in the pond waters could be modeled if attenuation factors could be obtained for degradation in the pond muds and waters, and losses from the surface; but no data are available to constrain these factors other than the limited pond – groundwater observations.

Current monitoring data indicates that the S1 groundwater plume is migrating toward the East Slough, and approximately 300 µg/L of vinyl chloride and 60 µg/L 1,2-DCA were reported in well S1-131, 50 feet from this pond, in August 2002. BIOCHLOR predictions of S1 concentrations reaching POE 1 reported above are used to represent likely concentrations of chlorinated COCs that may reach the surface water of the East Pond or East Slough at some future time.

There is also a residual benzene plume in the S1 at the east end of the lagoon, between wells S1-139 and S1-131. Benzene in S1-139 has been reported between 34 and 390 µg/L from 1998 through 2002, and between 3 and 50 ug/L in S1-131. This history indicates residual solute outside the sheetpile, away from the field of active remediation of the early 1990s, and in a groundwater stagnation zone. There is no significant benzene in the S1-123 plume to indicate this benzene occurrence is related to the S1-123 plume.

In 2002, pond bottom sediments and underlying UNC silty mud were sampled in the East Slough, adjacent to well S1-131, and from the East Pond near FLTG-14. At the same time water samples were collected from the middle and bottom depths of the ponds at these locations. Analyses of volatiles by EPA Method 8260 did not detect any volatile constituents, at method detection limits, which were 5 µg/L for benzene and vinyl chloride. Since the lab routinely reports "J" values to 1 µg/L, it is justifiable to assume pond concentrations no higher than one half the MDL, or 2.5 µg/L.

The non-detection of these two COCs in pond sediments and water, adjacent to monitoring wells showing up to 340 µg/L vinyl chloride and 390 ug/L benzene suggests an attenuation of at least 400/2.5 = 160/1 from groundwater to pond water. That is, microbial degradation appears to be maintaining concentrations below detection in pond bottom sediments; degradation, dilution and vapor losses from the pond provide a further attenuation capacity in reserve; and groundwater discharge to the ponds thus appears to have a concentration attenuation factor of at least 160. Because no volatiles were detected in the organic pond sediments, where they might have been adsorbed, the attenuation may actually be much stronger than this.

Using this demonstrably conservative "<1/160" rule, the following maximum pond water concentrations are estimated, when groundwater concentrations become steady adjacent to the ponds. Only predicted detections are given. The concentrations given in the table at S1-123 are as used in the BIOCHLOR model, namely the mean of post-1999 data plus two standard deviations. In all cases, this is slightly higher than the maximum reported concentration, and represents an upper 95% confidence level prediction of the sustained concentration at this nominal source.

Table 4-2
Maximum Concentrations of Chlorinated COCs in Pond Water

COC	Concentration in S1-123, 2002 µg/L	Concentration in S1 adjacent to pond, @ POE-1, 2050 µg/L	*Maximum* * concentration in pond µg/L	Criteria** µg/L
PCE	9,600	300	2	5 MCL 2,500 S 1,770 F 5 T
TCE	8,000	900	6	5 MCL 1,990 S 8,360 F 5 T
Cis 1,2-DCE	41,000	280	2	70 MCL NA S NA F 70 T
VC	4,000	290	2	2 MCL 94 S 65.7 F 2 T
1,2-DCA	330,000	20,000	125	5 MCL 1,450 S 1,010 F 5 T

* Maximum concentrations estimated from observed minimum attenuation

** MCL = federal drinking water standards; S= Recreational swimmer calculated screening level. See table D.2.5, F = fish ingestion; calculated screening level. See table D.2.6, T =Texas surface water criteria for fresh waters used for Protection of Human Health. See table D.2.5

Concentrations in pond water are attenuated from predicted S1 groundwater levels by presently observed ratios of 400:<2.55, i.e. at least 160:1. This leads not to a predicted concentration, but to an upper limit.

It is not expected that INT groundwater is able to impact surface water at any point, whether in near or far ponds. The INT is not believed to discharge to either East Slough or East Pond because of isolation by the C1 clay. Concentrations at POE 1 in the INT are predicted by BIOCHLOR to not exceed MCLs at any future time.

The model-predicted times to achieve standards through natural attenuation outside of the current compliance boundary area are:

vinyl chloride	1,2-DCA	benzene
20 years (2017)	22 years (2018)	19 years (2015)

5.0 RISK ASSESSMENT

A risk assessment following latest EPA guidelines is attached to this report as Appendix D. This section summarizes the health risks posed by the areas of recent concern at the French site. A schematic cross section showing groundwater flowpaths to points of exposure (POE) is given as Figure 5-1. This figure, in a section looking north toward the lagoon, shows groundwater flows to the west in the INT west plumes, and easterly in S1 and INT plumes in the east plumes. The window in the C1 allows downward communication in an area between the South Pond and the sheetpile. The locations of points of exposure used in the risk assessment are shown in Figure 5-2, which also shows the property under control by FLTG.

A summary of the calculated risks for the various exposure pathways is given in Table 5-1. The full calculation tables are available in Appendix D. The major conclusions of the risk assessment are as follows:

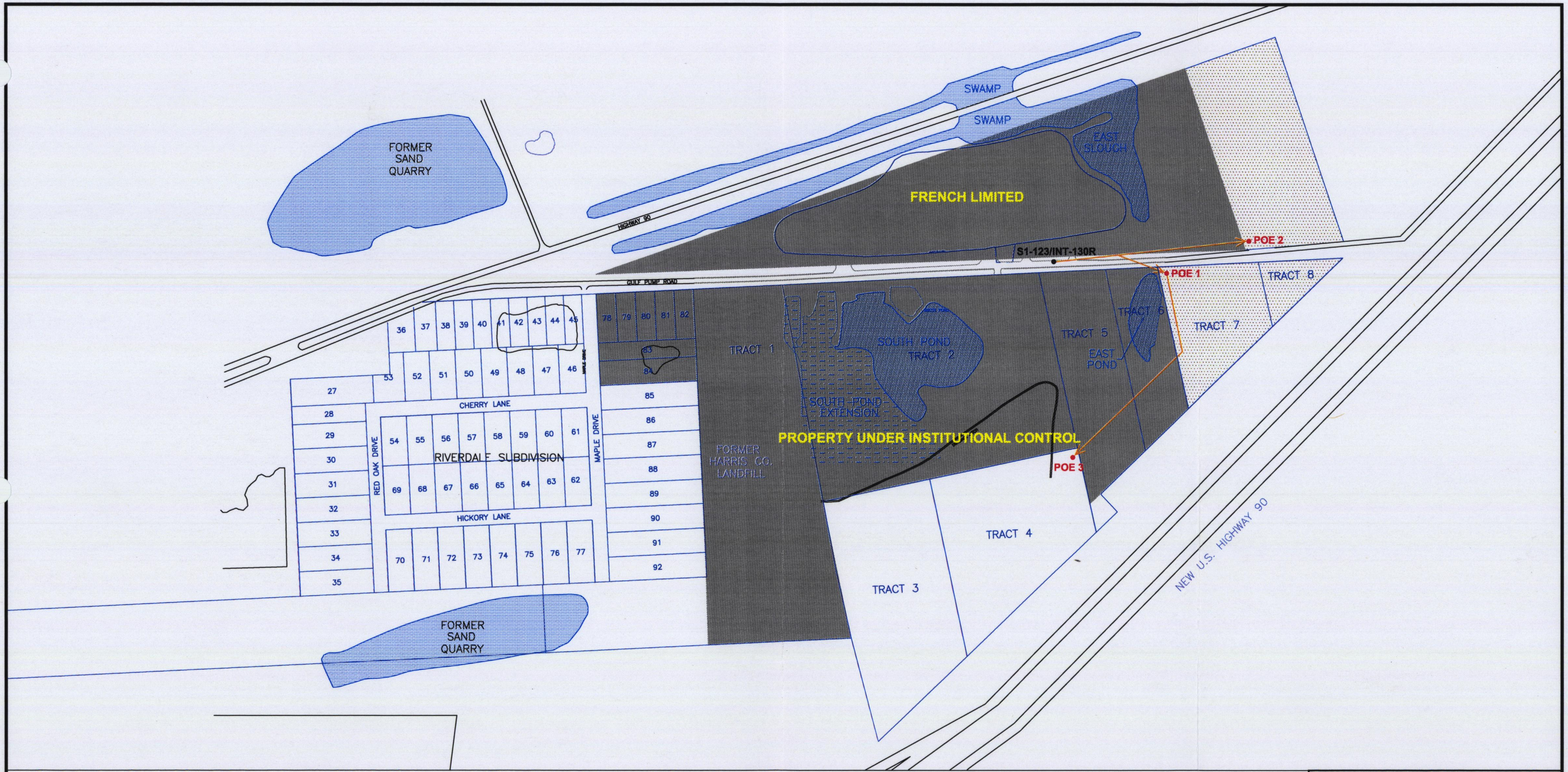
1. There is no current risk to public health or the environment.

2. There is no current or likely future exposure risk posed by INT groundwater. Current plumes are on property under the control of French, preventing potential pathways of exposure to INT water. No INT plumes are predicted to migrate off controlled property. West INT plumes are not migrating, are naturally attenuating and are projected to meet drinking water standards by 2018. On the other hand, some areas of INT groundwater off the site, but on property under French control, do currently exceed drinking water standards.

3. There is no current or likely future exposure risk posed by S1 groundwater via supply wells. Modeling predicts exceedences of MCLs in S1 groundwater outside present institutional controls in the future, but FLTG is in the process of imposing controls over all alluvial floodplain areas where groundwater impacts are predicted to be detectable.

4. Possible future impacts on pond water through discharge of affected S1 groundwater are difficult to quantify, but upper limits can be estimated by modeling groundwater concentrations and assuming an attenuation at least as much as currently observed, from existing S1 concentrations and non-detections of chemicals in pond sediments and water. Estimated cancer risks due to exposure to chemicals of concern reaching pond water are given in Table 5.1 and are detailed in the Appendix D Risk Assessment. The maximum estimated future risk for exposure to ponds impacted by S1 groundwater is 8.9E-7 for an adult, and 8.3E-7 for a child.

Groundwater and surface water will continue to be monitored on a regular basis, data will be assessed against these predictions and any unexpected deviations will prompt further reviews, and the protection of public health and the environment will be assured.



LEGEND

- POE LOCATIONS (HYPOTHETICAL POINT OF EXPOSURE WELL)
- MIGRATION PATHS
- PROPERTY UNDER CURRENT FRENCH CONTROL
- PROPERTY FOR WHICH INSTITUTIONAL CONTROLS ARE CURRENTLY PURSUED

250' 0 250'
SCALE IN FEET

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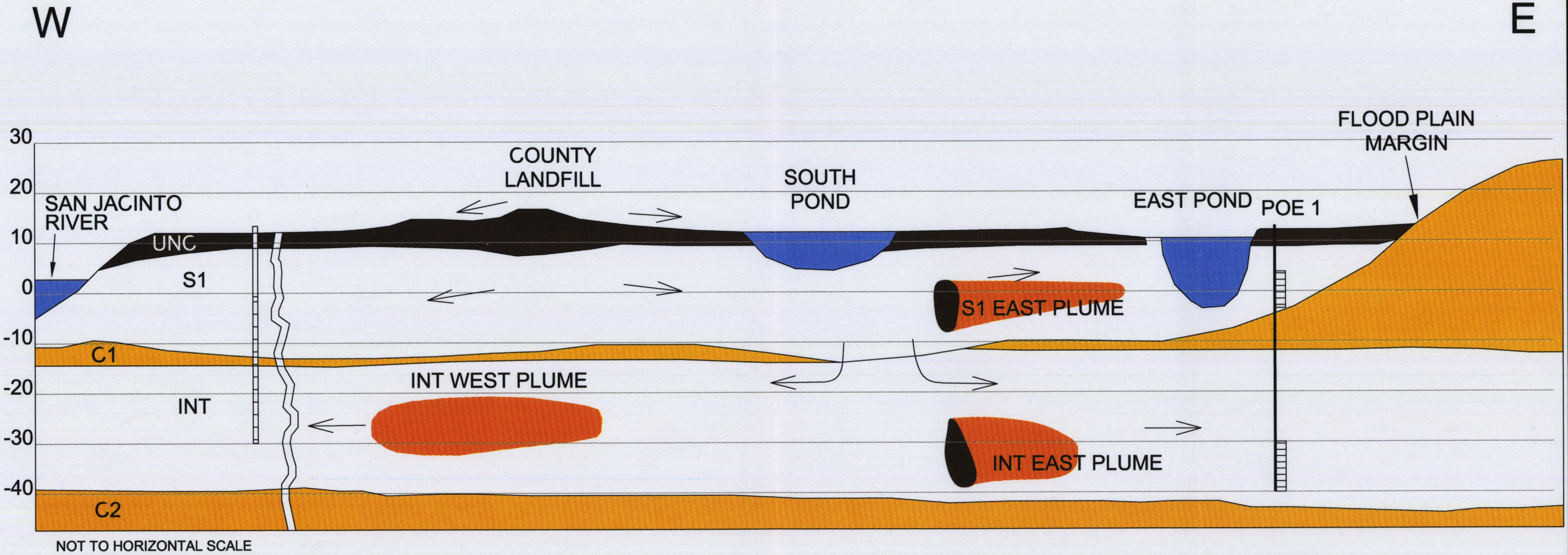
FIGURE 5-2
FRENCH PROPERTY UNDER INSTITUTIONAL CONTROL & POE LOCATIONS

DESIGN: TWG	DATE: 1/10/02	DRAWING NUMBER
DRAWN: JLS	SCALE: AS SHOWN	POE Locations.dwg
SCRIPT:		



FLTG., Inc
FRENCH LIMITED SITE
Crosby, Texas

FIGURE 5-1
SCHEMATIC EXPOSURE
PATHWAYS

DESIGN: AD	DRAWN: JLS	Drawing: Schematic Exp Pathways.dwg

Feb 10, 2003 - nS:\Auto Cad Projects\FRENCH\ FLTG Report Figures\Schematic Exp Pathways.dwg

Table 5-1
Summary of Exposure Risks in East Plume Area

Future exposure, resident adult swimmer – fisher

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk		
				Ingestion	Dermal	Exposure Routes Total
GROUNDWATER	SURFACE WATER	DERMAL CONTACT AND INGESTION FROM SWIMMING IN EAST POND	1,2-DICHLOROETHANE	9.5E-08	1.2E-09	9.6E-08
			TRICHLOROETHENE	5.5E-10	8.5E-11	6.4E-10
			VINYL CHLORIDE	1.2E-08	1.6E-10	1.2E-08
			Chemical Total	1.1E-07	1.4E-09	1.1E-07
		Exposure Point Total				1.1E-07
	Exposure Medium Total					1.1E-07
	FISH	EATING FISH CAUGHT IN EAST POND	1,2-DICHLOROETHANE	7.8E-07		7.8E-07
			Chemical Total	7.8E-07		7.8E-07
		Exposure Point Total				7.8E-07
	Exposure Medium Total					7.8E-07
Medium Total						
Receptor Total						8.9E-07

Table 5-1 continued
Summary of Exposure Risks in East Plume Area

Future exposure, resident child swimmer – fisher

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk		
				Ingestion	Dermal	Exposure Routes Total
GROUNDWATER	SURFACE WATER	DERMAL CONTACT AND INGESTION FROM SWIMMING IN EAST POND	1,2-DICHLOROETHANE	8.9E-08	4.2E-10	8.9E-08
			TRICHLOROETHENE	5.2E-10	2.9E-11	5.5E-10
			VINYL CHLORIDE	1.1E-08	5.6E-11	1.1E-08
			Chemical Total	1.0E-07	5.1E-10	1.0E-07
		Exposure Point Total				1.0E-07
	Exposure Medium Total					1.0E-07
	FISH	EATING FISH CAUGHT IN EAST POND	1,2-DICHLOROETHANE	7.3E-07		7.3E-07
			Chemical Total	7.3E-07		7.3E-07
		Exposure Point Total				7.3E-07
	Exposure Medium Total					7.3E-07
Medium Total						
Receptor Total						8.3E-07

6.0 REMEDIAL ACTION ASSESSMENT

The assessment of risk in the preceding section finds:

- No risk posed by current conditions to public health and the environment;
- No future risk posed by INT groundwater outside areas under institutional control;
- No current or future risk posed by S1 plumes except on property currently or imminently under institutional control;
- Potential future risk and exceedences of ARARs in surface water due to discharge of S1 groundwater to the East Pond and East Slough; this risk is believed to be conservatively over-estimated.

The INT west plumes are contained on French property, or on property on which institutional controls will prevent current and future exposure through water supply. Also, concentrations of COCs in the INT west plumes beyond the site boundary are projected to meet MCLs by year 2018.

The current plumes in the INT and the S1 in the east plumes area are contained on FLTG property, or on property on which institutional controls prevent current and future exposure. The margins of the source area in both the S1 and INT extend beyond the site boundaries on the south side of Gulf Pump Road. Thus, the institutional controls developed for this property provide long-term control of drilling or groundwater use in this area.

The east S1 and INT plumes may persist some time due to small residual sources, but the solute plumes poses no future risk at any location which is not under institutional controls.

<u>Potential future risk from S1 groundwater at compliance points:</u>

The likelihood of wells being installed at the current points of compliance where a positive risk was calculated is exceedingly small; groundwater concentrations are predicted to exceed MCLs at nearest points of compliance within a decade; property likely to be impacted in the future will be placed under institutional control to prevent actual exposure.

<u>Potential future pond impacts:</u>

Future concentrations estimated in surface water due to S1 groundwater discharge are upper bounds not actual predictions; future impacts are possible; continued monitoring will ensure that any such future impacts are responded to and exposure will be prevented.

Remedial alternatives have been outlined and assessed elsewhere. Practical, feasible and cost effective alternatives have been reduced to the following options:

- No action
- Controls
- Physical containment

No Action

The no-action alternative does pose some potential future risks to human health and the environment. Significant among these are potential impacts to surface water, for which only an upper bound has been estimated. The risk analysis shows high risk due to exposure to groundwater from a residential well installed at POE-1; however, the likelihood of a well being installed at a current point of compliance where a positive risk is calculated is exceedingly small, and institutional controls will be placed to prevent such a possibility. Under the no-action alternative groundwater concentrations are predicted to exceed MCLs at current points of compliance within a decade, but not to ever be detectable outside proposed controlled property.

The no-action alternative would continue groundwater and surface water monitoring on the present schedule to ensure no actual exposure risk by any pathway.

Controls

Institutional controls will be extended to cover locations of current compliance points, to prevent exposure at those points. These will include acquisition of property, imposition of deed controls, or possibly fencing of ponds to prevent or reduce the frequency of exposure through ingestion of fish, the most significant exposure potentially exceeding ARARs for surface water, should real imminence of such impacts be indicated by monitoring.

Containment

Physical containment of the S1 in the S1-123 area would prevent any future risks. Containment of the source area of the S1-123 plume would suffice to attenuate the plume, and prevent exceedence of MCLs at points of compliance and detectable impacts on surface water.

Containment of the INT is not necessary in east or west plumes. The risk assessment shows no foreseeable future risk posed by INT groundwater. Communication between S1 and INT is limited by the C1 clay and by small hydraulic gradients in the east plumes.

Other alternatives

Alternative actions seeking source reduction cannot effectively target small sources whose locations are not precisely known, so that such efforts are likely to be wasted. No infrastructure remains at the site to maintain any active remedial system involving groundwater circulation, vapor extraction, or other interventions. Remobilization is not practical.

APPENDIX A

Fate & Transport Modeling of COC Migration in INT West Plumes

Appendix A
Numeric Modeling of West VOC Plumes Fate and Transport

Numeric flow and transport modeling was performed to predict the future concentrations and distribution of selected species in groundwater in the western part of the French Limited Superfund site. Reactive transport modeling was performed for benzene, 1,2-DCA, and vinyl chloride. These species have the lowest health-based cleanup criteria of volatile organic compounds (VOCs) at the site, are the most mobile, and are the only VOCs exceeding their maximum contaminant level (MCL) outside the property boundary in the INT unit in this part of the site. Other VOCs are present in insignificant concentrations.

Modeling was performed for 40 years after shutting off the active remediation system in December 1995 and was limited to the INT aquifer in the western part of the site. The focus of the modeling effort was to confirm that the plumes would not reach the location of possible future water supply wells in the Riverdale area, and to ascertain when concentrations of dissolved organic constituents would decline to below clean-up criteria outside the compliance boundary. The parameters used to set up this model and the modeling results are presented in this appendix.

Model Code

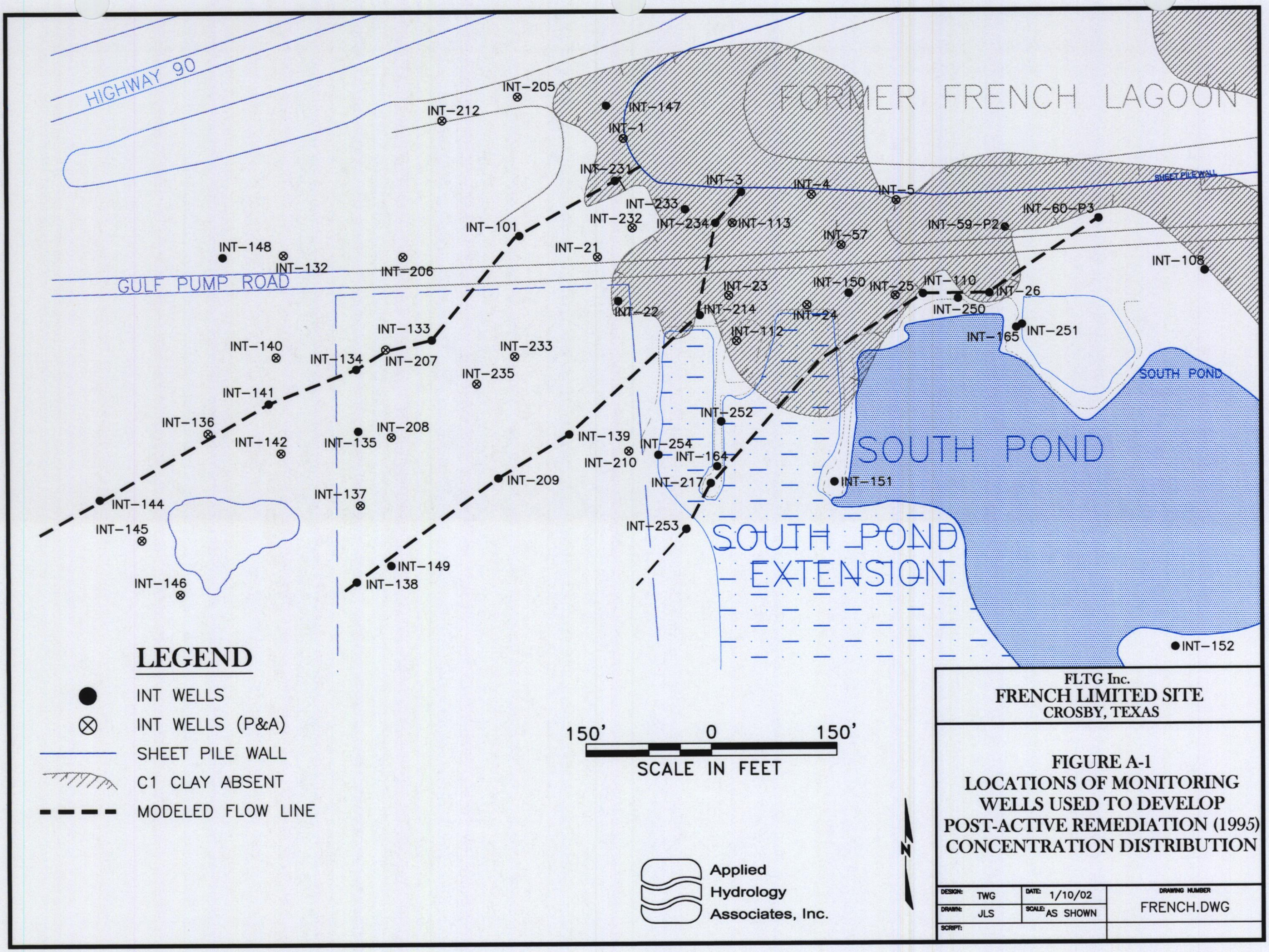
Visual MODFLOW© version 3.0.0.168, which uses the USGS MODFLOW 2000 finite difference engine, was selected for groundwater flow modeling based on its widespread acceptance and ease of use. The MT3DMS a multi-species public domain numeric engine, developed by the U.S. Department of Defense, was used for transport modeling. MT3DMS models advection, dispersion, sorption, and reactive transport.

Model Grid, Boundary Conditions and Parameters

For simplicity, the modeling was performed along the centerline of the two main INT West plumes (Figure A-1). The westernmost plume is defined by the INT-233, INT-134 and INT-144 wells. The second plume is bounded by the INT-26 and INT-217 wells. Simulations for both plumes were performed using a single layer, one-dimensional model grid aligned along the plume centerlines. For both models the grid length in the direction of flow was 1,000 feet. A total of 50 cells with a grid spacing of 20 feet was used for the INT-233/134/144 plume model. The model for the INT-26/217 plume used a mixed grid spacing of 10 or 20 ft spacing and had a total of 61 cells.

Modeled groundwater flow in the INT unit was assumed to be at steady state. Potentiometric monitoring data from 1995 to 2002 indicate very little change over this time period. The potentiometric gradient is maintained by recharge of the INT through C1 windows south of the lagoon with groundwater flow to the southwest towards the San Jacinto valley. Fixed head boundaries on the upgradient and downgradient ends of each model were set up to match the existing potentiometric gradient within the INT unit along the centerline of each plume.

The INT-233/134/144 model was set up with homogenous hydraulic conductivity, storativity, and effective porosity. The INT-26/217 plume model used a range of hydraulic conductivities. Modeling parameter details are summarized in Table A-1.



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CROSBY, TEXAS

FIGURE A-1
LOCATIONS OF MONITORING WELLS USED TO DEVELOP POST-ACTIVE REMEDIATION (1995) CONCENTRATION DISTRIBUTION

DESIGN: TWG	DATE: 1/10/02	DRAWING NUMBER
DRAWN: JLS	SCALE: AS SHOWN	FRENCH.DWG
SCRIPT:		

Initial Plume Definition

Sampling data from selected wells taken near the end of active remediation were used to develop "initial" concentration distribution maps for west INT plumes. The locations of wells used in the generation of these maps are shown in Figure A-1. Initial concentration distribution maps for benzene, 1,2 DCA, and vinyl chloride are shown in Figures A-2, A-3 & A-4. These maps were then used to create the initial concentrations along the centerline of the plumes. Groundwater monitoring data used to prepare the plume maps are presented in Table A-2. Data from sampling dates closest to the end of the active remediation period, December 1995, were used where available.

The French Limited project monthly progress report for November 1995 was used to determine the injection wells operating in November 1995. At these locations, values of zero for VOCs were assumed in constructing the concentration distribution maps. The zero values for VOCs in injection water are based on analyses of water from on-site supply wells screened at 250 feet in the Chicot aquifer. These supply wells, which were used for both injection water and potable water supply at the site, were analyzed frequently.

Model Calibration

Hydraulic and mass transport parameters, and first-order decay constants, were initially estimated from literature values, limited field data, and previous BIOTRANS modeling and then adjusted during model calibration. Model parameters were adjusted to calibrate the model to match simulated concentrations over time with actual concentration values at INT monitoring wells over the time period from 1995 to 2002. The primary parameters adjusted for calibration were the equivalent fractional organic carbon content of the INT unit and the first order reaction rates for the three-modeled species. The final parameters for the VOCs are shown in Table A-3.

Model Results

INT-233/134/144 plume model

Model simulation times were extended sufficiently for the plumes to attenuate to standards everywhere within compliance boundary. The INT-233/134/144 plume model results for each of the three VOCs, are illustrated as graphs of centerline concentrations through time at selected observation points in Figures A-5 through A-7. The results indicate that the concentrations of all three VOCs steadily decline over time as a result of natural attenuation processes.

The maximum extent of the plume, as defined by concentrations of any VOCs above the MCL, occurs in 2005 (model year 10) at a distance of about 120 feet beyond INT-144. Projected concentration distributions for 2005 indicate that compliance criteria are not likely to be attained based on the goal specified in the ROD. After this time, concentration declines result in the leading edge of the plume shrinking, with concentrations declining to less than MCLs in all parts of the plume beyond the compliance boundary by 2018 (model year 22). Benzene is calculated to be below MCL, site wide, after year 2015, 1 2 - DCA after 2018, and vinyl chloride after 2017.

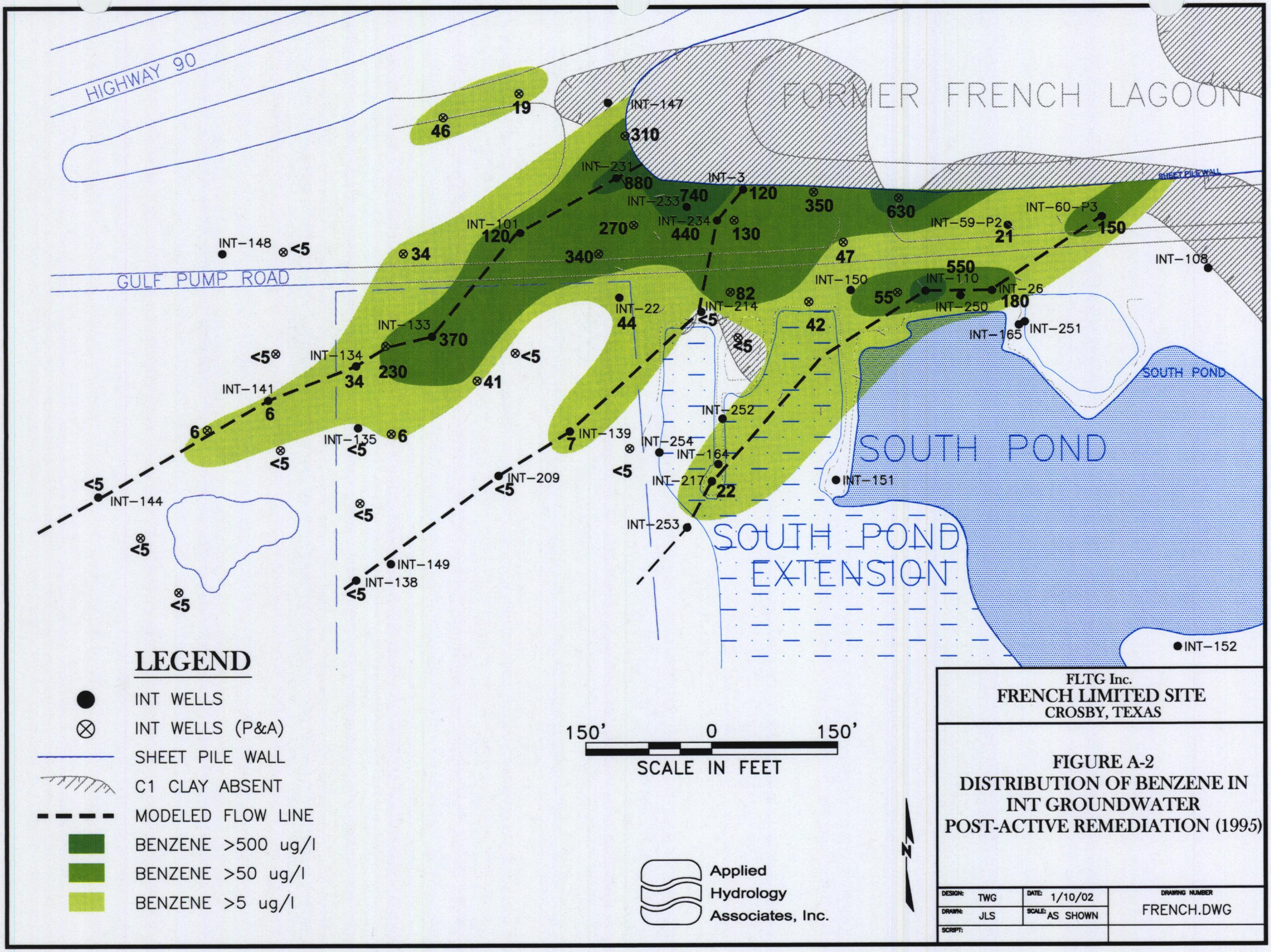
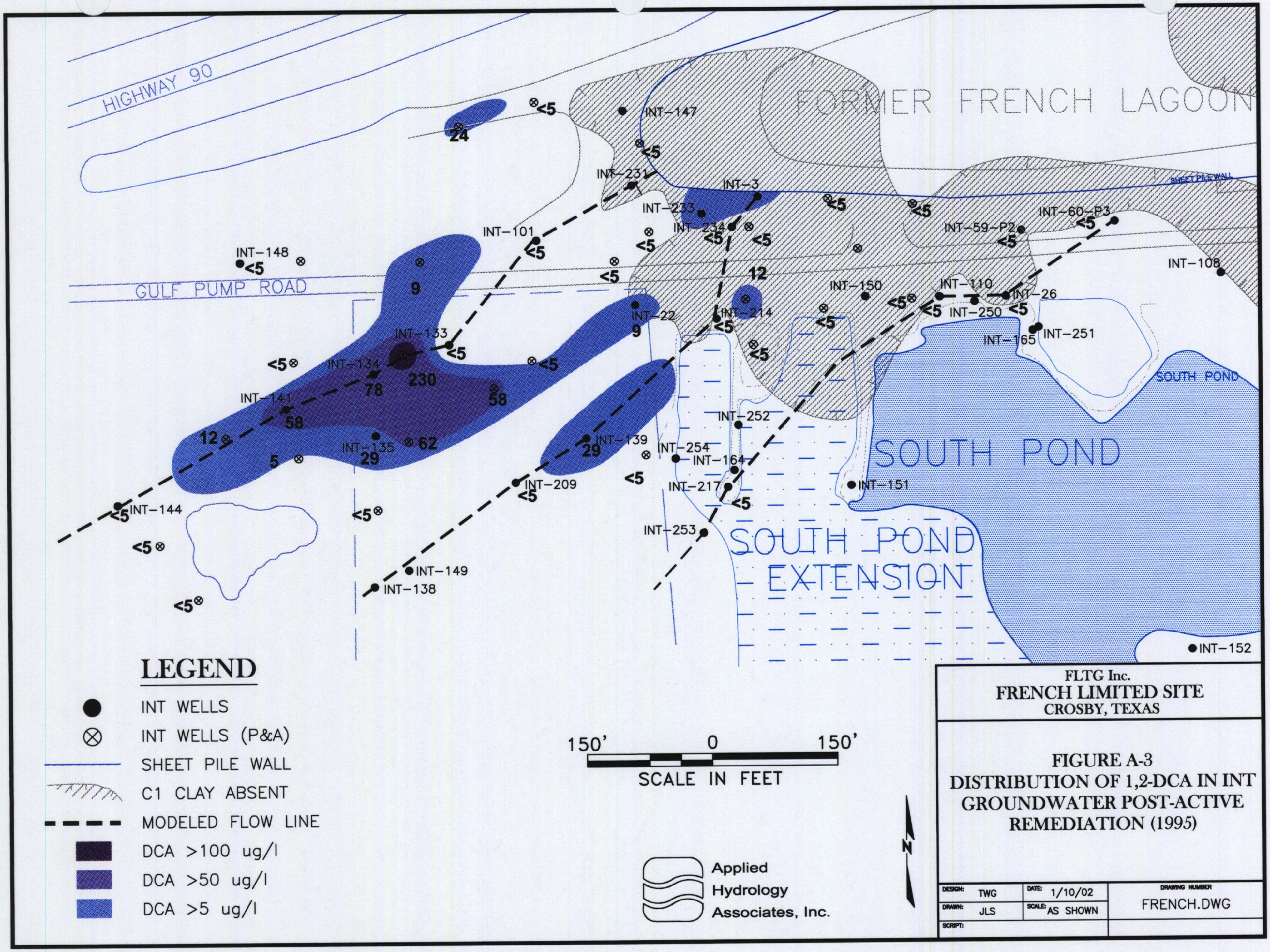


FIGURE A-2
DISTRIBUTION OF BENZENE IN INT GROUNDWATER POST-ACTIVE REMEDIATION (1995)


HIGHWAY 90
GULF PUMP ROAD
FORMER FRENCH LAGOON
SHEET PILE WALL
SOUTH POND
SOUTH POND
SOUTH POND EXTENSION
INT-147
INT-231
INT-3
INT-233
INT-234
INT-101
INT-148
INT-59-P2
INT-60-P3
INT-108
INT-150
INT-110
INT-26
INT-250
INT-22
INT-214
INT-165
INT-251
INT-133
INT-134
INT-141
INT-252
INT-135
INT-139
INT-254
INT-164
INT-209
INT-217
INT-151
INT-144
INT-253
INT-149
INT-138
INT-152
LEGEND
INT WELLS
INT WELLS (P&A)
SHEET PILE WALL
C1 CLAY ABSENT
MODELED FLOW LINE
DCA >100 ug/l
DCA >50 ug/l
DCA >5 ug/l
150' 0 150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
FLTG Inc.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE A-3
DISTRIBUTION OF 1,2-DCA IN INT GROUNDWATER POST-ACTIVE REMEDIATION (1995)
DESIGN: TWG
DATE: 1/10/02
DRAWING NUMBER
DRAWN: JLS
SCALE: AS SHOWN
FRENCH.DWG
SCRIPT:

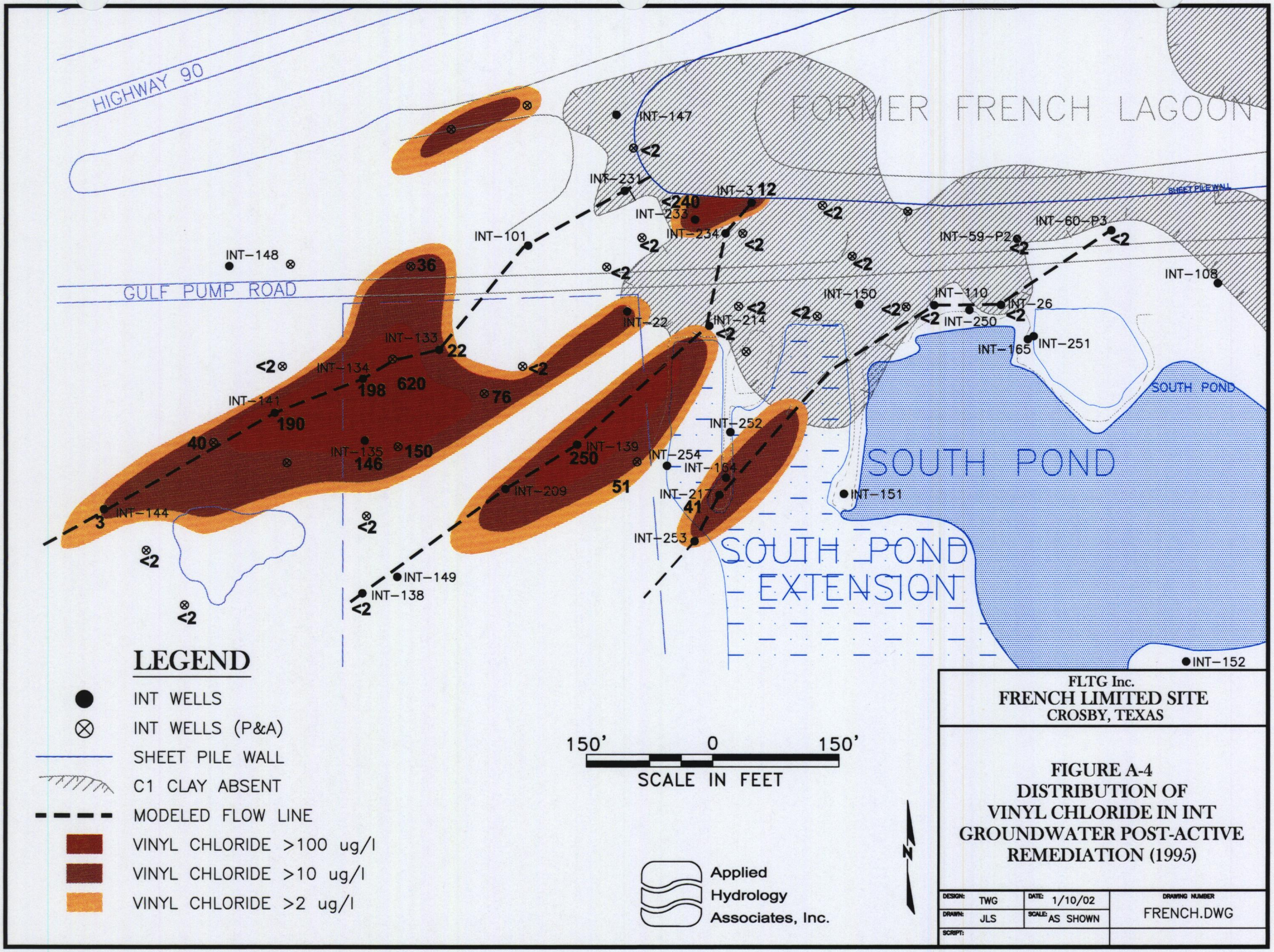

HIGHWAY 90
FORMER FRENCH LAGOON
GULF PUMP ROAD
SHEET PILE WALL
SOUTH POND
SOUTH POND
SOUTH POND EXTENSION
INT-147
INT-231
INT-3
12
<240
INT-233
INT-234
INT-101
INT-148
36
INT-22
INT-214
INT-150
INT-110
INT-250
INT-26
INT-59-P2
INT-60-P3
INT-108
INT-165
INT-251
INT-133
22
INT-134
198
620
76
INT-141
190
40
INT-135
146
150
INT-139
250
51
INT-209
INT-144
3
INT-252
INT-254
INT-164
INT-217
41
INT-253
INT-151
INT-149
INT-138
INT-152
<2
LEGEND
INT WELLS
INT WELLS (P&A)
SHEET PILE WALL
C1 CLAY ABSENT
MODELED FLOW LINE
VINYL CHLORIDE >100 ug/l
VINYL CHLORIDE >10 ug/l
VINYL CHLORIDE >2 ug/l
150'
0
150'
SCALE IN FEET
N
Applied Hydrology Associates, Inc.
FLTG Inc.
FRENCH LIMITED SITE
CROSBY, TEXAS
FIGURE A-4
DISTRIBUTION OF
VINYL CHLORIDE IN INT
GROUNDWATER POST-ACTIVE
REMEDIATION (1995)
DESIGN: TWG
DATE: 1/10/02
DRAWING NUMBER
DRAWN: JLS
SCALE: AS SHOWN
FRENCH.DWG
SCRIPT:

Figure A-5 - Modeled vs observed concentrations at INT-101 monitoring well

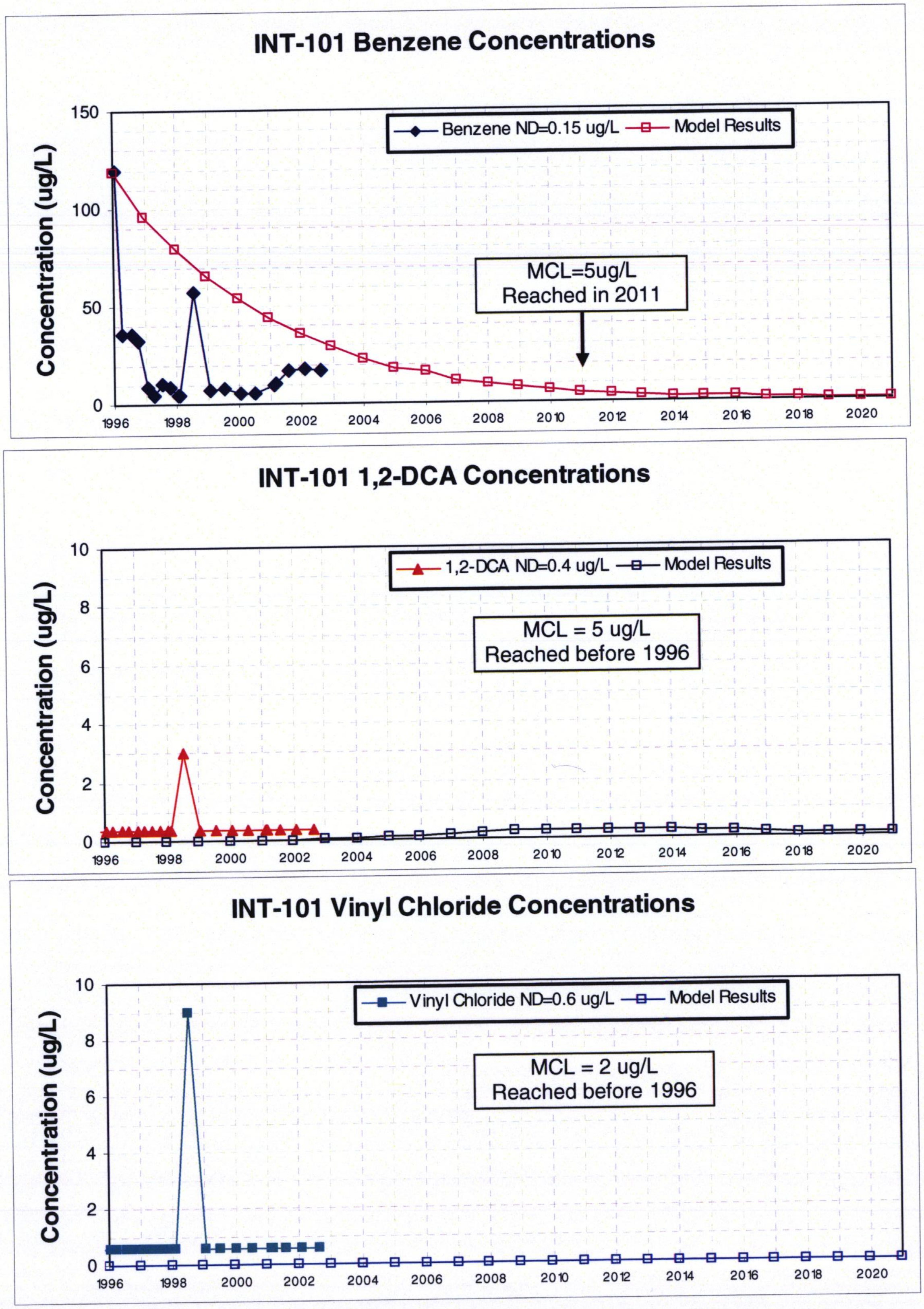
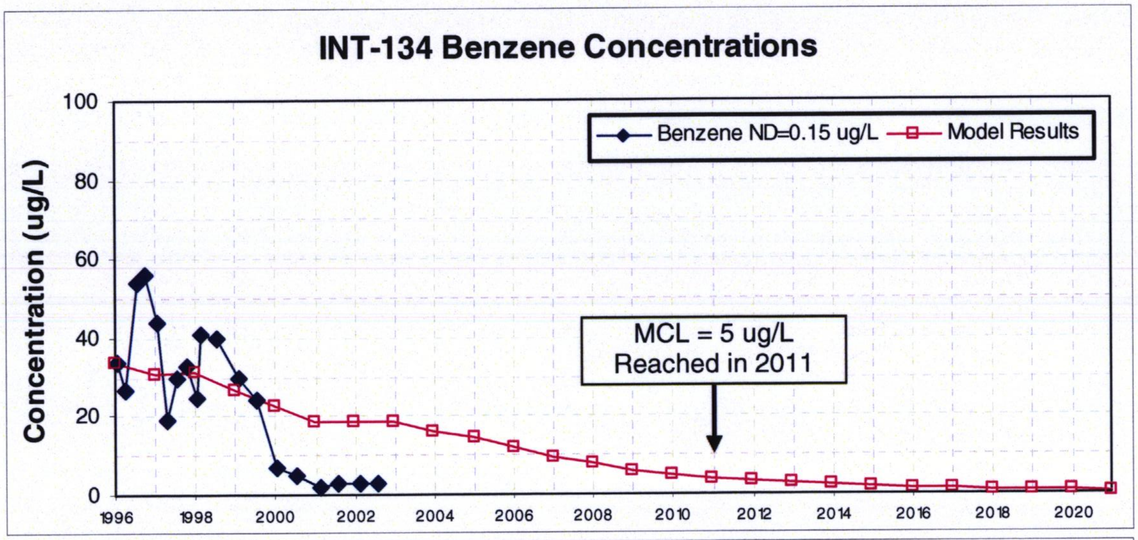
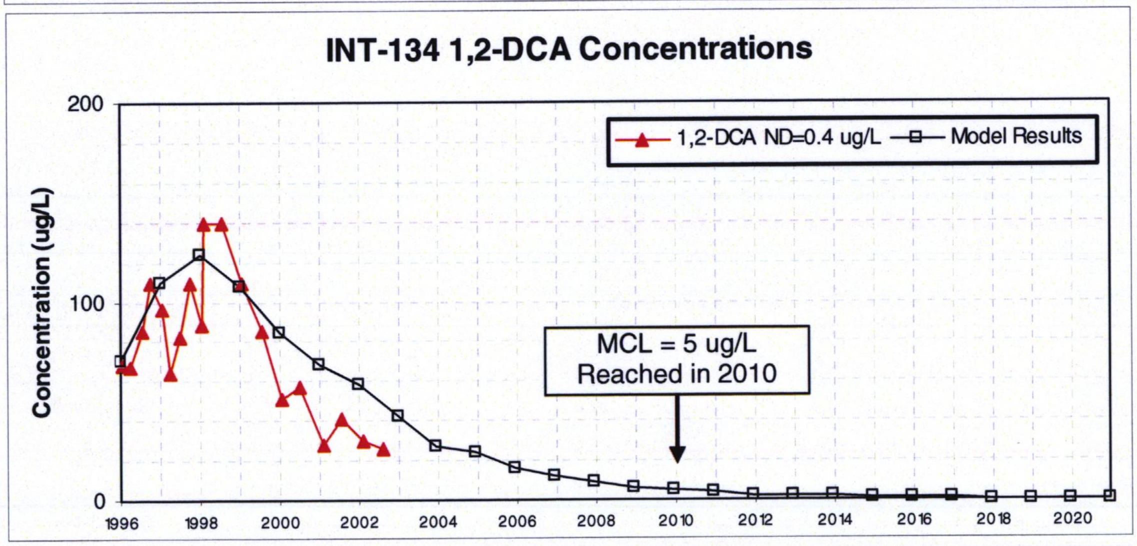


Figure A-6 - Modeled vs observed concentrations at INT-134 monitoring well





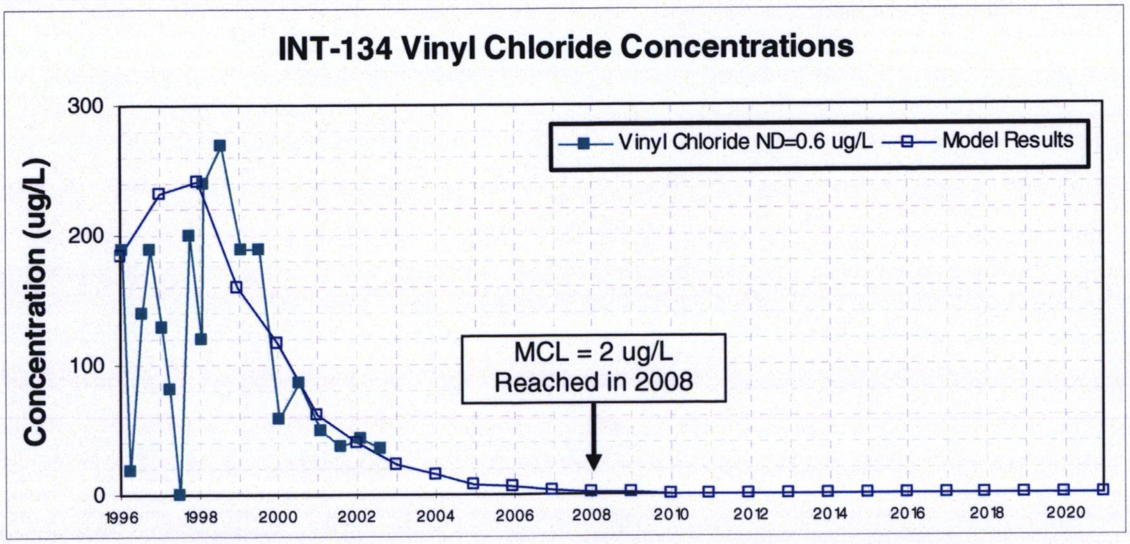


Figure A-7 - Modeled vs observed concentrations at INT-144 monitoring well

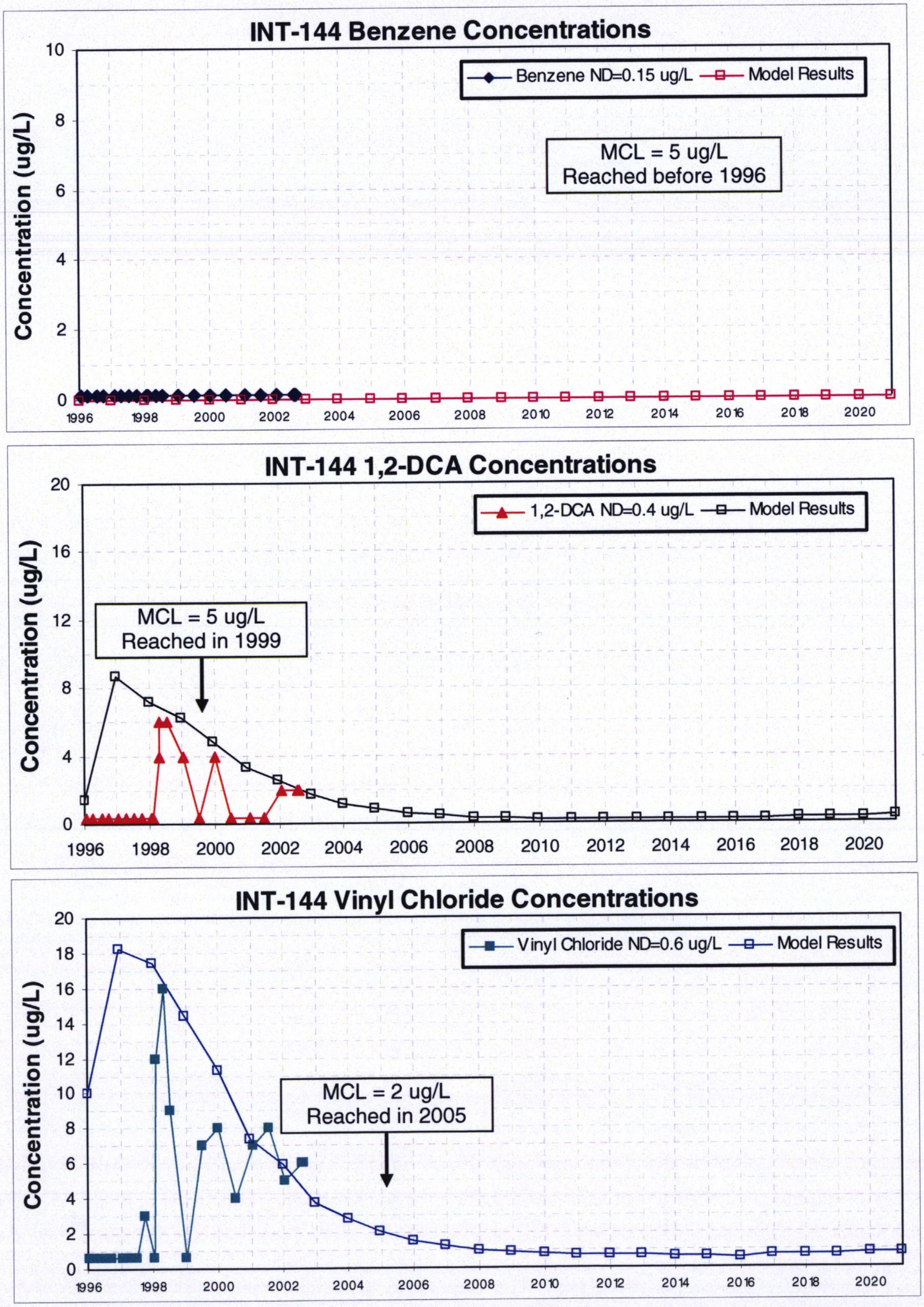


Table A-1
Parameters for INT-233/134/144 Plume Model

Parameter	Unit	Value
Grid Length (X direction)	ft	1,000
Grid Length (Y direction)	ft	50
Grid Size (X direction)	ft	20
Grid Size (Y direction)	ft	50
Number of Grids (X direction)	-	50
Number of Grids (Y direction)	-	1
Model Start Date	date	1/1/1996
Model End Date	date	1/1/2036
Dispersivity (longitudinal)	ft	10.0
Dispersivity Ratio (horizontal / longitudinal)	-	0.1
Dispersivity Ratio (vertical / longitudinal)	-	0.01
INT Unit Thickness	ft	20
Effective Porosity	-	0.1
Total Porosity	-	0.25
Conductivity X & Y	ft/day	5
Conductivity Z	ft/day	0.25
Conductivity Ratio X / Z	-	20
Bulk Density	Kg / ft^3	48

Parameters for INT-26/217 Plume Model

Parameter	Unit	Value
Grid Length (X direction)	ft	1,000
Grid Length (Y direction)	ft	50
Grid Size (X direction)	ft	10 and 20
Grid Size (Y direction)	ft	50
Number of Grids (X direction)	-	66
Number of Grids (Y direction)	-	1
Model Start Date	date	1/1/1996
Model End Date	date	1/1/2036
Dispersivity (longitudinal)	ft	10.0
Dispersivity Ratio (horizontal / longitudinal)	-	0.1
Dispersivity Ratio (vertical / longitudinal)	-	0.01
INT Unit Thickness	ft	20
Effective Porosity	-	0.1
Total Porosity	-	0.25
Conductivity X & Y	ft/day	2, 5 and 10
Conductivity Z	ft/day	0.2, 0.5, and 0.1
Conductivity Ratio X / Z	-	10
Bulk Density	Kg / ft^3	48

Table A-2
Initial VOC Concentrations for INT Wells (Used to Set Model Initial Concentrations)

Well Name	Benzene[1]	Vinyl Chloride[1]	1,2, Dichloroethane[1]	Date Sampled	Comment[2]
INT-022	9	19	9	10/01/95	
INT-025	14	0	0	02/05/95	
INT-025	2000	0	0		Concentrations extrapolated based on 1/27/99 sample. Earlier samples are considered suspect due to the potential of floodwater dilution.
INT-059-P-2	21	0	0	12/01/94	
INT-060-P-2	150	0	0	12/01/94	
INT-1	310	17	0	10/01/95	
INT-10[illegible]	530	3	0	12/21/94	Concentration Estimated at ½ DL
INT-110	550	0	0	12/01/94	
INT-111	15	27	0	12/01/94	
INT-112	0	0	0	12/01/94	
INT-113	0	0	0	12/01/94	
INT-132	0	0	0	12/21/94	
INT-133	86	12	0	12/21/94	
INT-134	0	200	367	12/21/94	12/21/94 DCA sample not in line with other samples so concentration extrapolated based on 6/7/94 sample.
INT-135	6	300	66	12/21/94	
INT-136	6	40	12	12/01/94	
INT-137	0	0	0	12/21/94	
INT-138	3	0	0	12/01/94	
INT-139	7	250	29	12/01/94	
INT-140	0	0	0	12/21/94	
INT-141	6	190	58	12/01/94	
INT-142	3	56	9	12/21/94	
INT-144	0	9	0	12/21/94	
INT-145	0	0	0	12/21/94	
INT-146	0	0	0	12/21/94	
INT-205	19	14	0	10/01/95	
INT-206	9	36	34	10/01/95	
INT-207	230	620	360	10/01/95	

Table A-2 (Continued)
Initial VOC Concentrations for INT Wells (Used to Set Model Initial Concentrations)

Well Name	Benzene[1]	Vinyl Chloride[1]	1,2, Dichloroethane[1]	Date Sampled	Comment[2]
INT-208	6	150	62	02/01/95	
INT-209	0	18	3	02/01/95	
INT-21	340	0	0	09/01/95	
INT-210	0	21	4	02/01/95	
INT-212	46	83	24	10/01/95	
INT-214	19	61	7	02/05/95	
INT-217	38	63	30	10/01/95	10/01/95 Benzene sample not in line with other samples so average concentration of 10/1/95 and 4/23/96 samples used.
INT-230	82	0	12	10/01/95	
INT-231	880	0	0	09/01/95	
INT-232	270	0	0	09/01/95	
INT-233	2300	240	200	09/01/95	Vinyl Chloride samples taken in September and November are suspect. ½ Detention limit of 1/23/96 sample was used.
INT-234	440	0	0	09/01/95	
INT-235	41	76	58	10/01/95	
INT-236	0	0	0	10/01/95	
INT-24	42	0	0	10/01/95	
INT-3	120	12	0	10/01/95	
INT-4	350	0	0	10/01/95	
INT-5	630	6	0	08/01/95	
INT-55	55	0	0	09/01/95	
INT-56	12	0	0	09/01/95	
INT-57	48	0	0	10/01/95	
REI-10-2	210	0	0	12/01/94	
REI-10-3	1000	2000	400	12/01/94	

1 Lab results reported below detection limits are treated as zero except when the detection limit was above the site cleanup criteria. In this instance 1/2 the detection limit is used for the concentration.

2 Injection wells were turned off December 1995. Initial concentrations at these points are treated as zero.

Table A-3

VOC Parameters for INT-233/134/144 Plume Model

Chemical	Koc (gm/L)	Equivalent *foc*	Kd (ug/L)	1st order Reaction rate (1/day)	Source
Benzene	66	0.06	3.9E-9	0.02	Howard
1,2-DCA	17.5	0.06	1.05E-9	0.002	Howard
Vinyl chloride	11	0.06	6.6E-10	0.003	Montgomery

VOC Parameters INT-26/217 Plume Model

Chemical	Koc (gm/L)	Equivalent *foc*	Kd (ug/L)	1st order Reaction rate (1/day)	Source
Benzene	66	0.03	2E-9	0.005	Howard
1,2-DCA	17.5	0.03	5E-10	0.0005	Howard
Vinyl chloride	11	0.03	3.3E-10	0.0007	Montgomery

Sources:

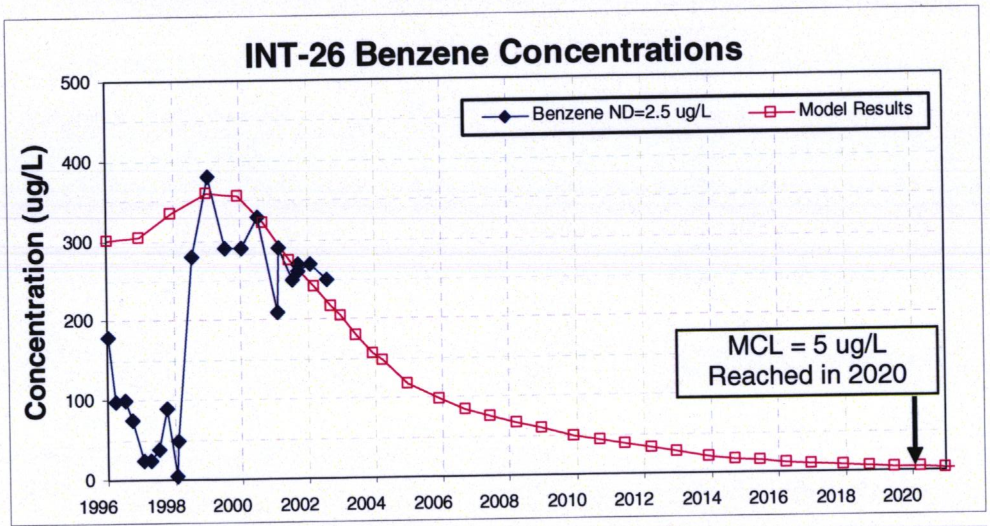
a) Howard, Philip, 1990, *Handbook of environmental fate and exposure data for organic chemicals, vol. II,* Solvents.
b) Montgomery, J. H., 1991, *Groundwater chemicals desk reference,* Lewis Publishers, Inc.

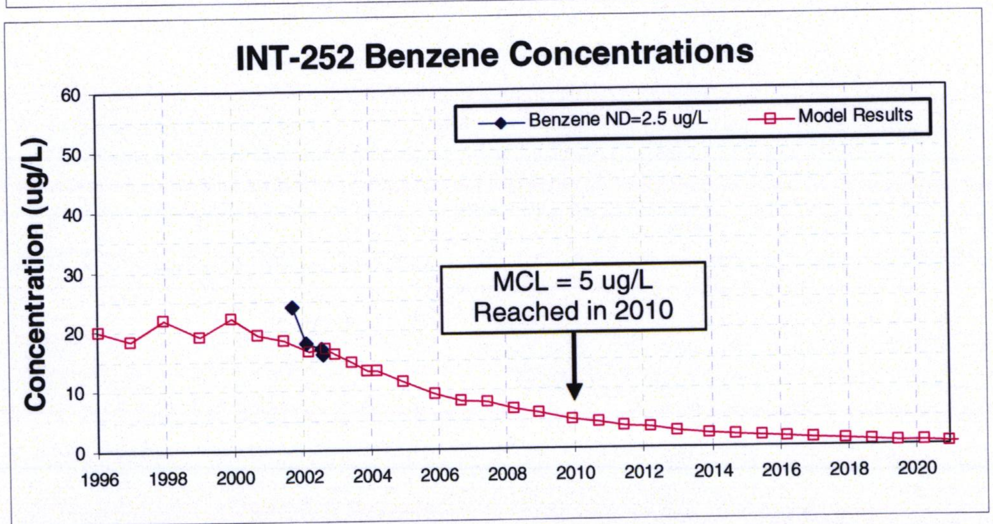
INT-26/217 plume model

The results for the INT-26/217 plume model, for benzene and vinyl chloride, are illustrated as graphs of centerline concentrations through time for each constituent at three selected observation points in Figures A-8 and A-9. The results indicate that the concentrations of these two VOCs steadily decline over time as a result of natural attenuation processes.

Projected concentration distributions for 2005 indicate that compliance criteria are not likely to be attained based on the goal specified in the ROD. After this time, concentration declines result in the leading edge of the plume shrinking, with concentrations declining to less than MCLs in all parts of the plume beyond the compliance boundary by 2020 (model year 24). Benzene takes longest to decline in the vicinity of the high concentration area around INT-26 but is projected to reach MCLs by 2020 in this area. Vinyl chloride is also projected to reach MCLs in 2020, with the area of longest decline in the vicinity of INT-252.

Figure A-8
Benzene Concentrations over Time at Selected Well Locations





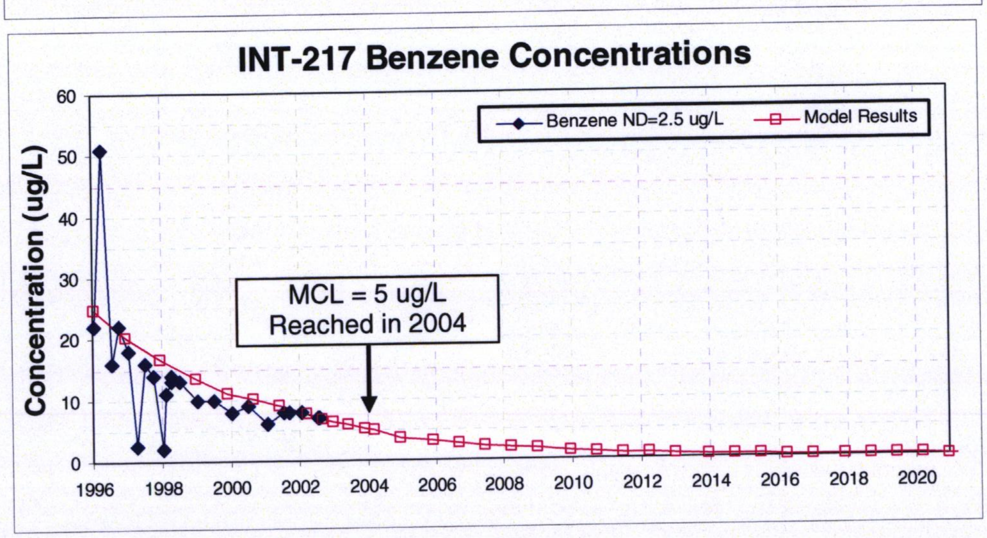
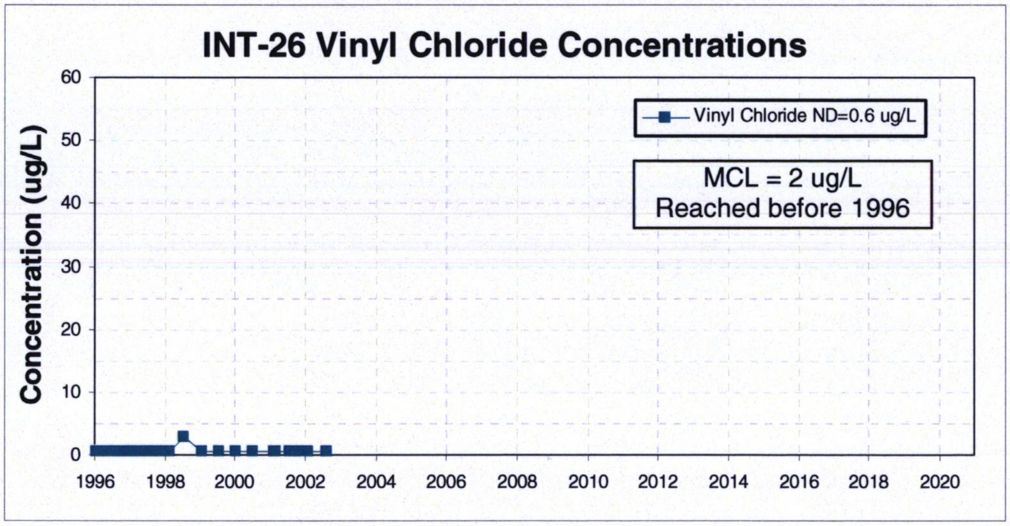
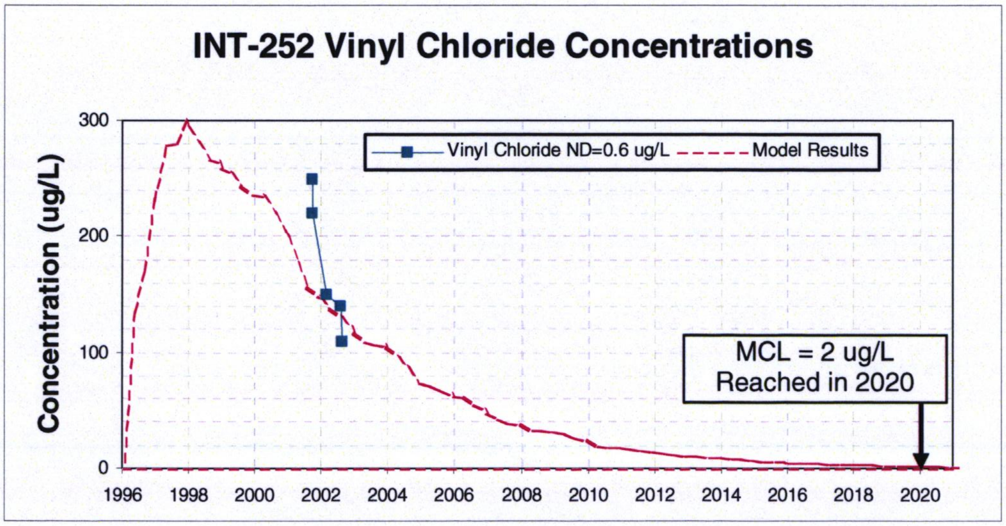
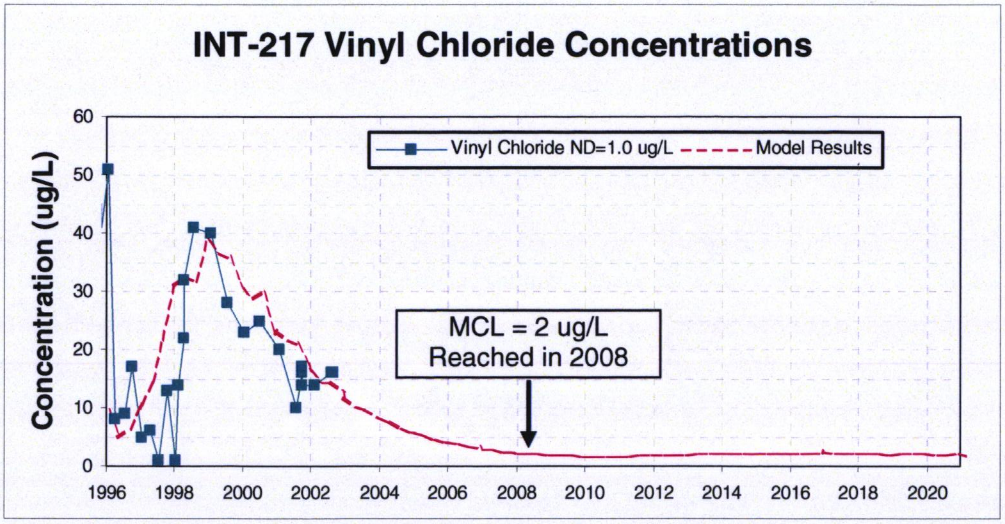


Figure A-9
Vinyl Chloride Concentrations over Time at Selected Well Locations







APPENDIX B

BIOCHLOR Modeling of COC Migration in East Plumes

BIOCHLOR files on CD

BIOCHLOR S1 East Plume Summary

Parameters

"Source" S1-123, constant strength
POE wells at distance 325 ft, 520 ft, 1000 ft
Hydraulic conductivity 0.01 cm/sec Gradient 0.002 *f*oc 0.005

COC	CT	CF	PCE	TCE	Cis 1,2-DCE	VC	TCA	DCA
Koc	186	47	155	93	29	11	110	17
Half life (days)	14 / 69	14 / 71	398 / 254	398 / 254	284 / 71	284 / 71	782 / 195	537 / 134

All Koc values from TRRP (RBCA) Guidelines, from literature values (as used in INT)
1st order degradation rates from INT west modeling (see table following)

S1 Results

		Concentrations, mg/L						
	File name	**S1-123**	**POE 1 x = 325 ft**		**POE 2 x = 520 ft**		**POE 3 x = 1,000 ft**	
COC		***2003***	***2010***	***2050***	***2010***	***2050***	***2010***	***2050***
CT	ES1C1	3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
CF	ES1C1	283	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
PCE	ES1ethEne	9.6	**0.3**	**0.3**	**0.03**	**0.04**	< 0.001	< 0.001
TCE	ES1ethEne	8	**0.9**	**0.9**	**0.09**	**0.15**	< 0.001	**0.001**
DCE	ES1ethEne	41	**0.28**	**0.28**	**0.03**	**0.04**	< 0.001	< 0.001
VC	ES1ethEne	4.1	**0.29**	**0.29**	**0.03**	**0.35**	< 0.001	< 0.001
TCA	ES1ethAne	0.2	**0.02**	**0.02**	**0.001**	**0.001**	< 0.001	< 0.001
DCA	ES1ethAne	330	**15**	**20**	**0.4**	**0.6**	< 0.001	< 0.001

CT = carbon tetrachloride; CF = chloroform; PCE = perchlorethylene; TCE = trichloroethylene; DCE = cis 1,2-dichloroethylene; VC = vinyl chloride;
TCA = 1,1,1-trichloroethene; DCA = 1,2-dichloroethane
2003 = model start time, based on post 1999 monitoring: concentration = mean of 2000+ data + 2 x std devn, in S1-123
DCE = sum of *cis* 1,2-, *trans* 1,2-, 1,1-DCE. properties as for *cis* 1,2-DCE (highest conc); DCA = 1,1- and 1,2-DCA, properties for 1,2-DCA
TCA reported concentrations generally less than PQL; 0.2 ~ 2 x mean PQL

BIOCHLOR INT East Plume Summary

Parameters

"Source" INT-130R, INT-130RS, constant strength
POE wells at distance 325 ft, 520 ft, 1000 ft
Hydraulic conductivity 0.001 cm/sec   Gradient 0.004   *f*oc 0.06 (*effective f*oc, from INT west plume models; includes clay effects)

COC	CT	CF	PCE	TCE	Cis 1,2-DCE	VC	TCA	DCA
Koc	186	47	155	93	29	11	110	17
Half life (days)	14 / 69	14 / 71	398 / 254	398 / 254	284 / 71	284 / 71	782 / 195	537 / 134

All Koc values from TRRP (RBCA) Guidelines, from literature values (as used in S1)
1st order degradation rates from modeling of west INT plumes (see table following): First value anaerobic, 2nd aerobic BIOCHLOR zone

Results

		Concentrations, mg/L						
	File name	**S1-123**	**POE 1 x = 325 ft**		**POE 2 x = 520 ft**		**POE 3 x = 1,000 ft**	
COC		***2003***	***2010***	***2050***	***2010***	***2050***	***2010***	***2050***
CT	EINTC1	19.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CF	EINTC1	17.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCE	EINTethEne	21	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
TCE	EINTethEne	2.0	<0.001	**0.003**	<0.001	<0.001	<0.001	<0.001
DCE	EINTethEne	4.2	<0.001	**0.001**	<0.001	<0.001	<0.001	<0.001
VC	EINTethEne	0.95	<0.001	**0.001**	<0.001	<0.001	<0.001	<0.001
TCA	EINTethAne	0.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
DCA	EINTethAne	15.8	<0.001	**0.001**	<0.001	<0.001	<0.001	<0.001

CT = carbon tetrachloride; CF = chloroform; PCE = perchlorethylene; TCE = trichloroethylene; DCE = cis 1,2-dichloroethylene; VC = vinyl chloride;
TCA = 1,1,1-trichloroethene; DCA = 1,2-dichloroethane
2003 = model start time, based on post 1999 monitoring: concentration = mean of 2000 - 02 data, + 2 x std devn, in INT-130R, RS
(using well at which particular COC mean concentration higher)
DCE = sum of *cis* 1,2-, *trans* 1,2-, 1,1-DCE. properties as for *cis* 1,2-DCE (highest conc);   DCA = 1,1- and 1,2-DCA, properties for 1,2-DCA
TCA reported concentrations generally less than PQL ~ 0.1; 0.2 at source ~2 x PQL

First Order Degradation Rates
(days)

COC	Howard Aerobic		Howard Anaerobic		Selected Near-source Anaerobic Zone	Selected Distal Aerobic Zone
	Low value	High value	Low value	High value		
CT	28	168	7	28	14	69
CF	28	180	7	28	14	71
PCE	180	360	98	1620	398	254
TCE	180	360	98	1620	398	254
DCE	28	180	112	720	284	71
VC	28	180	112	720	284	71
TCA	140	273	560	1092	782	195
DCA	100	180	400	720	537	134

Source =Howard, Boethling, Jarvis, Meylan, Michelenko, 1991. Environmental Degradation Rates. Lewis Pub.
Values used = geometric means of ranges; checked by calibration of INT west plumes

Use anaerobic values in Biochlor Zone 1 (head of plume), aerobic rates in Zone 2.

*f*oc in INT adjusted to accord with INT west model. Effective *f*oc accounted for by retardation of interbedded silt and clay in INT, rather than actual carbon content.

APPENDIX C

Mann - Kendall Test for Trend in INT-144

Mann – Kendall Non-Parametric Test of Attenuation Trends

The Mann-Kendall test is a common non-parametric test of whether a data trend is increasing or decreasing. It is commonly invoked to prove attenuation of constituents of concern.

The Kendall test method is described in Numerical Recipes[6], an authoritative standard in computational tools, as "Kendall's Tau", for ordered data pairs (x_i, y_i). In the Mann-Kendall adaptation, the sequence of single-variable values (x_i, concentrations) is written in the first column and first row of an array. In the upper half of the array, a -1, 0 or +1 is entered in each cell depending on whether the value is less than, equal to or greater than the preceding value. That is, each value is compared to all subsequent values. Summing the values gives the test statistic S.

Kendall and Mann worked out the confidence levels from the combinatorics, and a simplified table (shown below) has been generated by Wilson for determination of a decreasing trend at a 90% confidence level. In this figure, the hatched area shows values of the test statistic that indicate a decreasing trend with 90% confidence.

	Total Number of Samples						
S	4	5	6	7	8	9	10
-4							
-5							
-6							
-7							
-8							
-9							
-10							
-11							
-12							
-13							
-14							
-15							
-16							

In this table, if the net score of comparisons of 8 ordered samples is less than -12 (at least 12 more pairs are decreasing than increasing), then it is said that the level of confidence that the trend is decreasing is 90% or better.

A Mann-Kendall plot of the vinyl chloride concentration data from INT-144 groundwater is shown below. The data begin after active remediation ceased, with the first reported detection of vinyl chloride.

[6] Press, Flannery, Teukolsy and Vetterling, 1986 (1st ed) . Numerical Recipes: The art of scientific computing. Cambridge University Press, 820 p.

Mann - Kendall Worksheet for INT-144

	Event 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8	# 9	# 10	# 11	# 12	
Sampling date	5/4/98	5/ 4/98	7/22/98	1/21/99	7/14/99	1/13/00	7/11/00	2/ 7/01	7/25/01	1/29/02	8/ 6/02	8/21/02	
Concentration (µg/l)	**16**	**30**	**9**	**1**	**7**	**8**	**4**	**7**	**8**	**5**	**6**	**6**	Row Totals
16		1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-9
30			-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-10
9				-1	-1	-1	-1	-1	-1	-1	-1	-1	-9
1					1	1	1	1	1	1	1	1	8
7						1	-1	0	1	-1	-1	-1	-2
8							-1	-1	0	-1	-1	-1	-5
4								1	1	1	1	1	5
7									1	-1	-1	-1	-2
8										-1	-1	-1	-3
5											1	1	2
6												0	0
6													
							S score = total count of pair comparisons					**Total**	**-25**

The test statistic is -25 (there are 25 counts more in which values decreased than increased, in pair comparisons); there are 12 consecutive analyses (N = 12). The requirement for > 90% confidence determination that the trend is decreasing, for 12 consecutive values, is S < -19.
S= -25 < -19; so the Mann-Kendall test concludes it is better than 90% certain that the trend is in fact decreasing, i.e. it supports the inferred attenuation of vinyl chloride in INT-144.

APPENDIX D

Risk Assessment

RAGS D Planning Tables

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RAGS D Planning Tables

Appendix D

RISK ASSESSMENT

D.1 Introduction

This risk assessment evaluates the potential risk posed to public health and the environment by each of the three small areas with affected groundwater remaining at the French Limited (FLTG) site. The plumes include benzene and vinyl chloride solutes extending southwesterly from the west end of the lagoon (west INT plumes), and mixed chlorinated chemicals in both the S1 unit and the INT near the southeast end of the former lagoon (S1 and INT east plumes). The ROD for the French Limited Site addresses remediation of the "upper aquifer", which is comprised of both the S1 and INT units. Although the east S1 and INT are superposed, the chemical compositions of the two indicate separate residual contamination sources in the S1 and in the INT, and their fate and transport and response options are different, consequently, they are evaluated independently in this risk assessment. The remedial action target for the "upper aquifer", or S1 and INT, is that a 10^{-6} cancer risk should be attained within a 10-year period at compliance points.

No quantitative risk evaluation is performed for a hypothetical receptor immediately adjacent to the French Limited site on the South Side of Gulf Pump Road at the current groundwater compliance points. The fate and transport analyses in Section 4 indicate that future concentrations in groundwater at these compliance points are either steady or declining, but current concentrations in S1 and INT exceed groundwater MCLs, and the east plumes are unlikely to reach compliance at the current boundary in the foreseeable future. COC concentrations in the west plumes are predicted to meet compliance through natural attenuation by 2018. Therefore, the current controls on well water use will need to be extended, and long institutional controls will need to be implemented to control drilling, excavation, and groundwater use in this property. French does now have control through lease and ownership of most property on the south side of Gulf Pump Road, including all off-site areas that are currently impacted by chemicals in groundwater.

An earlier risk assessment (DNAPL Study Risk Evaluation, AHA, April 1994) was developed and submitted in response to the detection of DNAPL outside the French Limited Lagoon cutoff wall. This risk assessment was developed to:

- analyze the risk of residual contamination that currently occurs at the site following completion of active remediation; and
- determine the need for further action to provide adequate protection of public health and the environment.

A draft Focused Feasibility Study of the S1-123 / INT-130R Area was submitted to EPA in May, 2002. The risk assessment submitted in Draft Focused Feasibility Study of the S1-123 / INT-130R Area has subsequently been updated to include the west INT plumes, address EPA comments on the draft, and to follow the latest EPA Risk Assessment Guidance.

D.2 Conceptual Model

The conceptual model shows the possible receptors and exposure pathways, and provides the overall framework for the risk analysis. Separate conceptual models are developed for the INT-west plumes, and the east S1 and INT plumes, as shown in Figures D-1A, D-1B and D-1C, respectively.

D.2.1 Exposure Setting

The French site is approximately one mile south of Crosby, Texas and one-half mile west of Barrett, Texas. The combined population of the Crosby/Barrett area is approximately 6,000 based on the 1990 census. Municipal water supply wells for the towns of Crosby and Barrett do exist within a 1-mile radius of the site, but these wells are completed in the Chicot Aquifer, typically at depths in excess of 200 feet. The Chicot Aquifer is hydrogeologically separated from the shallow alluvial aquifer of the French Limited site. As a result, public water supply consumers of Crosby and Barrett are not considered to be a potentially exposed population through this drinking water pathway. The water supply well used to support activities at the French Limited site is located on the east end of the site. The well is also completed in the Chicot Aquifer at a depth of 220 feet. Routine monitoring of this well has confirmed that no organic constituents related to the French Limited site appear in the Chicot aquifer unit.

The closest residences are in the Riverdale Subdivision, approximately 500 feet southwest of the French Lagoon. These consist of single-family homes on one-acre lots. Many of the Riverdale residences had shallow domestic wells completed in the shallow sands. The potential for exposure to groundwater from these shallow wells has been reduced by converting most to monitoring wells and by installation of a deep potable water well. Furthermore, due to frequent flooding of the Riverdale Subdivision, most of the residents have been relocated to locations outside the floodplain.

The entire site and the ground water transport and potential exposure points lie within the floodplain of the San Jacinto River. The floodplain is undeveloped and used mostly for recreation. The abandoned sand pits in the area are occasionally used by fishermen and the San Jacinto River is used for boating, fishing, and water sports. Farming occurs in the outlying areas and some sand mining operations continue to operate along the San Jacinto River and its tributaries.

The property south of the site and currently under the control of FLTG Inc is shown in Figure D-2. French controls indicated property through lease or ownership, is moving to purchase leased tracts, and is pursuing institutional controls on property that may possibly be impacted at some future time, indicated by a different pattern. Controls will prevent development or installation of water wells, thus closing potential future exposure pathways. FEMA and wetlands rules restrict residential or commercial development in these locations.

D.2.2 Receptors

As indicated in Figures D-1A through D-1C, the possible human receptors considered in this risk assessment are persons fishing or swimming in ponds and sloughs, personnel involved in any construction that breaks ground, and residents who might at some future time install a supply well in the floodplain downgradient of the site. Utility workers could be exposed to shallow soil and groundwater in trenches or pole borings. Ecological receptors are surface waters in ponds near the site that are locations for groundwater discharge.

D.2.3 Exposure pathways

Exposure pathways consist of the following four elements:

1. a source and mechanism of chemical release,
2. a retention or transport medium (or media in cases involving media transfer of chemicals),
3. a point of potential human contact with the contaminated medium (referred to as the exposure point),
4. an intake route (e.g., ingestion) at the contact point.

Tables describing the selection of exposure pathways were developed in accordance with the EPA Risk Assessment Guidance for Superfund (RAGS), Part D. Separate exposure pathway tables are developed for the INT-west plumes, and east S1 and INT plumes, as Tables D-1a, D-1b and D-1c, respectively.

INT-West Plumes

Groundwater in the west INT plumes migrates southwesterly toward the Riverdale Subdivision. A groundwater exposure pathway to the Riverdale residential area is not complete, since the downgradient reaches of these plumes are not advancing. The modeling and monitoring results presented in Section 4 both demonstrate that the plumes are stationary and are shrinking in many areas. Fate and transport modeling indicate that the groundwater restoration goal of less than 10^{-6} cancer risk for exposure to groundwater in these areas will be attained by year 2018.

Nevertheless, a pathway to a hypothetical well located southwest of the site and sourcing the INT is considered in this risk assessment as indicated in Table D-1a. Clearly a supply well completed at the location where the concentrations are highest in the INT West plumes would exceed drinking water standards and the 10^{-6} cancer risk. The exposure concentrations are declining and are expected to continue to decline over time. Although the plumes are currently out of compliance, property control ensures that there is no complete exposure pathway or actual risk to human health.

The groundwater downgradient of the INT west plumes in all likelihood discharges to the San Jacinto River southwest of the site. This exposure pathway to surface water is not included in this assessment as the downgradient extensions of the INT west plumes are stationary and the plumes are attenuating. No shallow soil exposure pathways exist, since no detectable concentrations are known in the upper 10ft in any of the west plumes area.

East Plumes area

Groundwater in both the S1 and the INT in the east plumes flows easterly, parallel to the sheetpile wall. This flow direction is controlled by the sheetpile wall, and by recharge on the south side of the wall from the former county landfill and the South Pond. The S1 groundwater flows toward the East Slough and East Pond and is hydraulically connected to these surface water bodies. Although the groundwater in the INT flows in the same direction as the S1 the INT is not connected to these ponds. The groundwater in both the S1 and the INT apparently turns southerly at the edge of the floodplain, but there are no monitoring wells located to the east of the ponds to confirm this.

Exposure to organic contaminants from the S1-123/INT-130R source area could occur by:

- well installation south of Gulf Pump Road
- groundwater discharge to ponds used for recreational purposes, or
- off-site groundwater users located downgradient of the site and on property not under French control, or
- shallow excavation for utility installation and repair along Gulf Pump Road.

A hypothetical supply well south of Gulf Pump Road near the S1-123/INT-130R source area site clearly would currently exceed drinking water standards and the 10^{-6} cancer risk. Only a qualitative risk is reported for a hypothetical receptor at such a well in Tables D-1b and D-1c. Long-term institutional controls will need to prevent installation of such wells.

S1 groundwater discharge to surface water ponds constitutes an exposure pathway for ecology and recreational exposure of visitors. Recreational visitors can be exposed through dermal contact with pond water and ingestion, and ingestion of fish caught in the ponds as shown in Table D-1b. The East Pond and East Slough are currently unfenced exposure points, though not currently impacted. These ponds are not very appealing as recreational sites as domestic trash is frequently dumped on their roadside margins and hundreds of castoff tires have been dumped in the East Pond. The likelihood of people swimming or fishing in the East Pond is small; some fishing does occur in the East Slough. Aesthetic discouragement does not remove these ponds from exposure considerations. Only the S1 groundwater is in contact with and can discharge to surface pond water in the vicinity of the site.

Access to the South Pond is restricted by a high fence with locked gates, and is under French control. The South Pond is a prolific ecosystem, with beaver, alligators, cormorants and osprey at the top of wildlife food chains. South Pond fauna are not ecological receptors, because the South Pond is up-gradient from the S1-123 / INT-130R area. Also, beaver dams currently maintain elevated water levels in the South Pond, so that it recharges the S1. Loss of the beaver dam would lower the elevation of the pond and decrease this recharge rate, affecting the hydraulic gradients in both S1 and INT groundwater. However, since the French limited lagoon cutoff wall remains in place and the South Pond and the S1 still receive recharge from the landfill area, an easterly direction for groundwater flow is likely to be maintained in both the INT and the S1, so that the South Pond would not become a potential discharge point for groundwater from the S1-123 / INT-130R area.

Table D-1c does not include an exposure pathway to surface water from the INT. There is no hydraulic connection between the INT and either the East Slough and East Pond. The INT groundwater could eventually discharge to the S1 south of the site. The modeling and monitoring results presented in Section 4, both demonstrate that natural attenuation precludes any COC migration from the site in the INT groundwater to any current or future potential receptors.

Despite current and proposed institutional controls, potential exposure points are identified in this risk assessment at nearest currently uncontrolled locations, to assess potential risk at those points, demonstrate attenuation trends, and to predict possible pond water impacts. The nearest location at POE-1 is used to assess possible impacts to ponds; POE-1 and POE-2 predict possible future risk at points that would be highly unlikely to be developed and will be brought under institutional control, and POE-3 predicts future risk at the nearest potential well location without pending controls. BIOCHLOR modeling predicts that MCLs of several COCs may be exceeded in the S1 at POE-1 and POE-2 at some future time (a steady state, stationary plume is developed in about 2020, with a steady strength source), and that low concentrations, less than MCLs for all COCs, might possibly be detectable in the S1 at POE-3 in 2050. BIOCHLOR predicts no detectable INT impacts at any of the POE locations from the east plumes.

Tables D-1b and D-1c include exposure pathways in both the S1 and the INT to a potential receptor located at either POE-1 or POE-2. This receptor could obtain water from either the S1 or the INT, or from both units. A well installed in the S1 at the POE-1 location would draw some water from the East Pond, which is hydraulically connected to the S1.

Potential groundwater exposure concentrations and risk are calculated only for the POE-3 location, as the closest location with any possibility of development that would lead to such exposure. Calculations are performed independently for the S1 and the INT as sources and transport processes are distinct for each unit.

The conceptual model for the S1 in Figure D-1b includes a potential exposure pathway for inhalation or adsorption from impacted soils during excavation of shallow trenches or augering of post holes for cable and utility installation and repair. The Endangerment Assessment Report prepared by ERT (February 1987) in support of the RI/FS and the EPA ROD found trace contamination in shallow soils outside the lagoon to pose no hazard to human health. Subsequent monitoring of VOC concentrations during drilling investigations and monitoring well installation in the S1-123 / INT-130R area and along Gulf Pump Road have detected no volatile emissions from shallow soils requiring the use of PPE or engineering controls during these activities.

Local building practice and a shallow water table preclude deep excavation for building foundations so that a possible exposure pathway, via direct dermal contact, ingestion or inhalation of constituents in the S1is not considered complete (no exposure). Furthermore, direct dermal contact, ingestion or inhalation of contaminants as a result of deeper excavation or drilling operations associated with remedial actions at the site is not considered in this Risk Assessment because these activities are performed under closely controlled and monitored conditions.

D.3 Chemicals of Potential Concern

D.3.1 Risk Assessment Data Set

French maintains a data base of all site data. All recent water samples have been analyzed for volatiles at the Turtle Bayou laboratory near Liberty, TX, under EPA methods and QA/QC guidelines. Digital copies of the database, and quality control documentation, are maintained by French and are available on request.

Quality assurance duplicate samples and lab calibration checks are reported in each monitoring report, which is now performed on a semi-annual basis. Each monitoring report summarizes all historic data for key wells and for surface water ponds.

D.3.2 Screening for Chemicals of Potential Concern

Tables showing the occurrence, frequency of detection and screening of chemicals of concern are developed for the INT-west and east S1 and INT plumes. These tables include both current and future COC concentrations for all exposure pathways identified in Section D.2 of this report.

INT West Plumes Area

Tables D.2.1 and D.2.2 include the maximum and minimum COC concentrations and detection frequencies for the current year (2002) from INT wells located in West Plumes area. The screening concentrations listed in these tables were taken from the Tier 1 Groundwater PCLs in the Texas Risk Reduction Program. Arsenic was detected above the screening level at one well located at the former Harris County Landfill. Elevated arsenic has been observed at the landfill in the past, but not elsewhere in the area, so the landfill arsenic level is used as the screening concentration. Table D.2.1 screens maximum observed groundwater concentrations against ingestion standards (MCLs), and Table D.2.2 screens for inhalation of vapors during residential use of the water. Ingestion and inhalation are the only pathways for potential exposure to contaminants in the west INT plumes. The COCs surviving screening are 1,2 DCA, benzene and vinyl chloride, for ingestion of water from a hypothetical supply well in the INT west plumes.

S1 East Plumes Area

Tables D.2.3 and D.2.4 show screening for COCs based on maximum groundwater concentrations in the current year (2002) from off-site S1 wells in the east plumes. The COCs passing screening for ingestion of groundwater in this S1 plume are 1,2 DCA, 1,2 DCE (cis & total), benzene, PCE, TCE, and vinyl chloride. The maximum offsite concentrations are in those wells nearest Gulf Pump Road. These contaminant concentrations are at approximately steady levels, so current and future concentrations are assumed to be the same.

Tables D.2.5 and D.2.6 show screening for COCs in surface water in the East Pond (or East Slough) due to discharge of S1 groundwater in the future. Current concentrations in the surface water in the ponds are all below detection, and only the predicted future exposure pathway (modeled year 2050) is evaluated. The concentrations used in the screening for COCs are maximum concentrations predicted by BIOCHLOR fate and transport modeling in Section 4 (based on predicted future S1 groundwater concentrations next to the ponds, and minimum attenuation from groundwater to pond)

The screening concentrations in Table D.2.5 for dermal contact and ingestion while swimming in East Pond or East Slough were developed using risk-based criteria from the Oak Ridge National Laboratory Risk Assessment Information System. The screening criteria are for a 10^{-6} target risk for exposure to carcinogenic chemicals, and a target hazard index of 1.0 for exposure to noncarcinogenic chemicals. The procedures used to calculate the risk based screening criteria are provided in Table D.2.5a. An exposure frequency of one day per year is used in the calculation because of the very unappealing character of these ponds as swimming holes. Dermal and ingestion contact due to intentional swimming is unlikely but incidental contact could occur during boating or fishing.

Screening for ingestion of fish is shown in Table D.2.6, comparing predicted maximum pond concentrations with criteria from the Oak Ridge National Laboratory Risk Assessment Information System. These screening criteria were also determined using a 10^{-6} target risk for exposure to carcinogenic chemicals and a target hazard index of 1.0 for exposure to non-carcinogenic chemicals. The procedures used to calculate these criteria are provided in Table D.2.5b. An exposure frequency of 12 days per year was chosen because use of these ponds for fishing occurs infrequently, as more attractive fishing locations are found in the vicinity.

Tables D.2.5 and D.2.6 also include the Texas Surface Water Criteria for Fresh Waters Used for Protection of Human Health for Waters Not Designated or Used for Public Water Supply, as potential ARARs for these surface water bodies. The maximum modeled concentrations are compared with both the screening criteria and potential ARARs for COCs in surface water. For surface water, 1,2 DCA is the only COC surviving screening, through future potential exposure.

For the foreseeable future the east S1 plume is likely to fail risk based screening levels at the current compliance boundary on Gulf Pump Road, regardless of any remedial action. Current controls will be extended to long-term institutional control of the property south of Gulf Pump Road, as indicated in Figure D-2. Nearest potential exposure points POE-1 and POE-2 on Figure D-2, at the boundaries of the currently controlled area, are on tracts for which French is also pursuing long term institutional control. POE-3 is therefore the nearest potential exposure point. Since the current concentrations in groundwater in the S1 are below detection in the vicinity of this POE location, only the future exposure pathway is evaluated. Tables D.2.7 and D.2.8 show screening for COCs in S1 groundwater at POE-1, predicted by BIOCHLOR in the year 2050. The screening concentrations listed in these tables are from Tier 1 Groundwater PCLs in the Texas Risk Reduction Program. The COCs in this analysis are 1,2 DCA and vinyl chloride, neither of which survives screening.

INT East Plumes Area

Tables D.2.9 and D.2.10 show east INT plume screening for COCs in groundwater, based on maximum concentrations in the current year (2002) from INT wells beyond the site boundaries in the east plumes. The COCs from this analysis are 1,2 DCA, 1,2 DCE (total), benzene, carbon tetrachloride, methylene chloride, naphthalene, PCE, trans 1,2-DCE, TCE, and vinyl chloride.

The maximum concentrations are in those wells nearest Gulf Pump Road. These concentrations are approximately steady, so that current and future concentrations are assumed to be the same.

There is no surface water pathway for groundwater in the INT in the east plumes. Furthermore, the long institutional control needed for the property south of the Gulf Pump Road would apply to both the S1 and the INT groundwater. POE-1 is the nearest potential exposure point for groundwater in the east INT plume. The current concentrations in groundwater in the INT are below detection in the vicinity of this POE location, and the BIOCHLOR-modeled future concentrations are below screening levels, as shown in Tables D.2.11 and D.2.12

D.4 Derivation of Exposure Point Concentrations

This section describes the procedures and information used to calculate exposure point concentrations for the quantitative risk calculations. The tables have been developed in accordance with the EPA RAGS D Guidance and include only future or predicted concentrations. From the COC screening analysis presented in Section D.3, the maximum concentrations in the west INT plumes and in the east S1 and INT plumes exceed both the French Limited groundwater restoration target levels and acceptable risk-based screening levels. A quantitative risk analysis is not performed for these exposure pathways because the concentrations currently pose unacceptable risk for exposure, but the current pathway is not complete because of institutional controls on this property, which prevent groundwater exposure. Current concentrations in the surface water of the ponds and in groundwater at off-site POE locations are below detection limits.

Table D.3.1rme shows highest estimated exposure concentrations for the COCs in surface water in the East Slough and/or East Pond for comparison with criteria based on dermal adsorption and ingestion of water during swimming or contact recreation. Table D.3.2rme provides highest exposure concentrations for pond water for criteria based on ingestion of fish. The exposure concentrations are predicted by S1 groundwater transport modeling and attenuation from groundwater to receiving pond water, as developed in Section 4.

Groundwater exposure concentrations at POE-1 are not developed. French is pursuing institutional controls for the tracts of POE-1 and POE-2. S1 groundwater is predicted to exceed MCLs at POE-1 and POE-2 at some future time; INT groundwater is not.

D.5 Determination of Chemical Intake Parameters

Potential future exposure to chemicals of concern in groundwater and surface water of a residential population by the following routes was identified:

1. Incidental ingestion of contaminated surface water while swimming.

2. Dermal contact with contaminated surface water while swimming.

3. Ingestion of fish caught from contaminated ponds.

4. Consumption of S1 groundwater from a hypothetical supply well at the nearest uncontrolled point of exposure downgradient of the east plumes, namely POE-3.

Intakes for these exposure routes were calculated in applicable tables from the EPA RAGS D Guidance. The parameters in the intake calculations for ingestion and dermal exposure for future swimming in the East Pond or the East Slough are summarized in Table D.4.1rme. The parameters used in the intake calculations for ingestion of fish caught in the East Pond or the East Slough are summarized in Table D.4.2rme. Groundwater exposures are not calculated, since no COCs pass screening at POE-3, the nearest exposure point not under current or future institutional controls.

D.6 Toxicity Assessment

This section provides the toxicological basis to determine the cancer toxicity parameters in the quantitative risk calculations. Tables are developed in accordance with the EPA RAGS D Guidance and include only future or predicted concentrations. In the analysis in Section D.2.3, no chemicals that exceeded the risk-based screening for non-cancer toxicity. Consequently, this section includes no Table D.5 corresponding with Table 5 in the EPA RAGS D Guidance.

Table D.6.1 provides toxicity information for COCs in the oral/dermal exposure pathway in the east plumes. The latest information on toxicity of specific chemicals was obtained from the Integrated Risk Information System (IRIS), which is an EPA database containing up-to-date health risk and regulatory information for numerous chemicals. IRIS contains only toxicological reference data (RfDs, slope factors, unit risks, etc.) that have been verified by the EPA Work Groups and supersedes all other sources.

D.7 Risk Calculation

This section provides a summary of the variables used to calculate the chemical cancer risk for each exposure pathway in the quantitative risk assessment. Tables included in this section have been developed in accordance with the EPA RAGS D Guidance. Table D.7.1rme provides risk calculations for the future adult recreational user of the East Pond or the East Slough when COCs are at their highest predicted concentrations in these water bodies. Risk is calculated for exposure via ingestion and dermal adsorption during swimming or contact recreation, and via ingestion of fish caught in these ponds. Table D.7.2rme provides the same risk calculations for a child.

No risk is calculated for east plumes groundwater exposure, because current and future potential concentrations at the nearest uncontrolled exposure points are below screening criteria.

There were no radiological chemicals detected at the site. Consequently, this section includes no Table D.8 corresponding with Table 8 in the EPA RAGS D Guidance.

D.8 Risk Summary and Uncertainty Evaluation

This section provides a summary of the cancer risk for each receptor for all exposure media, points and routes. The tables of this section follow the EPA RAGS D Guidance. Table D.9.1rme sums risks for an adult, and Table D.9.2.lrme for a child, in the future when COCs reach predicted maximum concentrations at all exposure points. The risk summary assumes that the same individual is exposed through ingestion and dermal adsorption during swimming or contact recreation; ingestion of fish caught in these ponds, and residential use of groundwater at POE-3.

No Table D.10 corresponding with Table 10 in the EPA RAGS D Guidance is provided because the risks for S1 groundwater vanish with proposed institutional controls for POE-1 and POE-2. Groundwater in the S1 emanating from the S1-123 source area may pose a future risk through pond exposure.

These conclusions are based on conservative assumptions regarding potential exposure points, frequency of exposure, and contaminant transport. The calculated future cancer risk to a recreational user of the East Pond or the East Slough is approximately 10^{-6}. This assumes a regular exposure of a user over a lifetime of fishing and dermal adsorption and ingestion on an annual basis at these ponds. The actual exposures that comprise this risk are unlikely, since the ponds are not frequently visited by fishermen and are more often used as a dumping site.

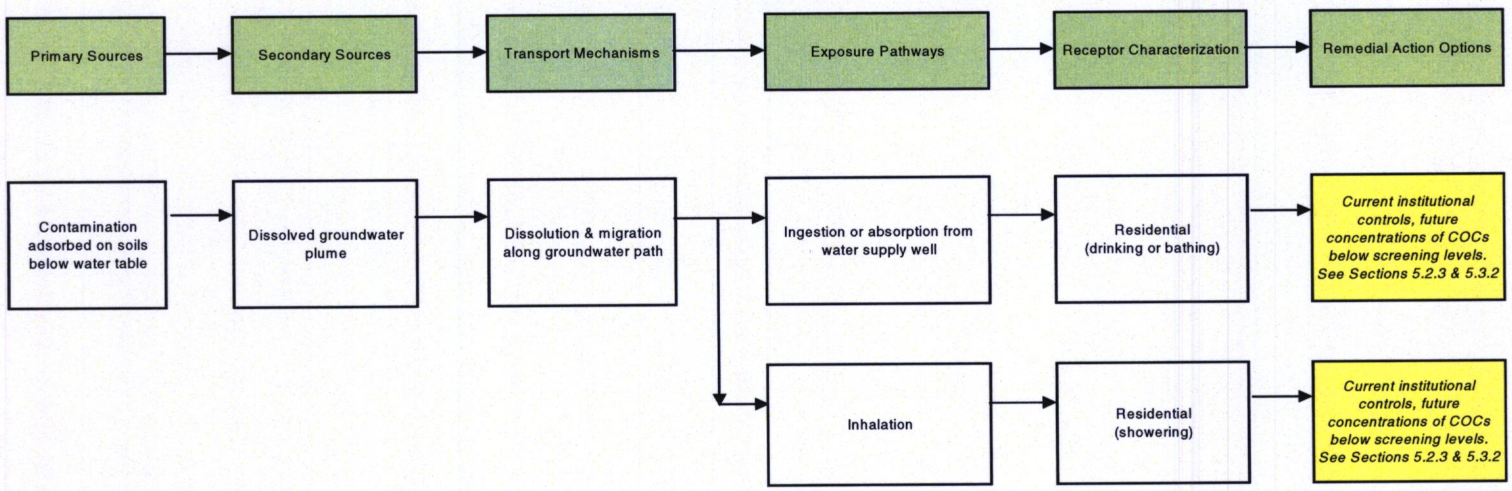
The principal uncertainties in surface water exposure concentrations are the rate of groundwater discharge to the ponds and degradation rates of chemicals through the bottom muds and in the pond water. The attenuation from groundwater to receiving pond water is modeled in Section 4 by currently observed concentrations in each, but these yield a factor which is believed to be a minimum attenuation, since concentrations in the ponds are not detectable. Thus the results are biased toward overestimating the future exposure concentrations and thus the carcinogenic risks.

The calculated future cancer risk to a residential user of the S1 groundwater at the nearest uncontrolled potential point of exposure is less than 10^{-6}. Groundwater exposure is dependent on the future location of a well, and the concentrations reaching it. A supply well in the floodplain east of the site is itself improbable, and the possibility is to be restricted by imposition of institutional controls.

Other sources of uncertainty are the rates of attenuation of chemicals along the flow path, which are modeled by an extensive database for the west INT plumes, but may vary depending on such factors as oxygen recharge.

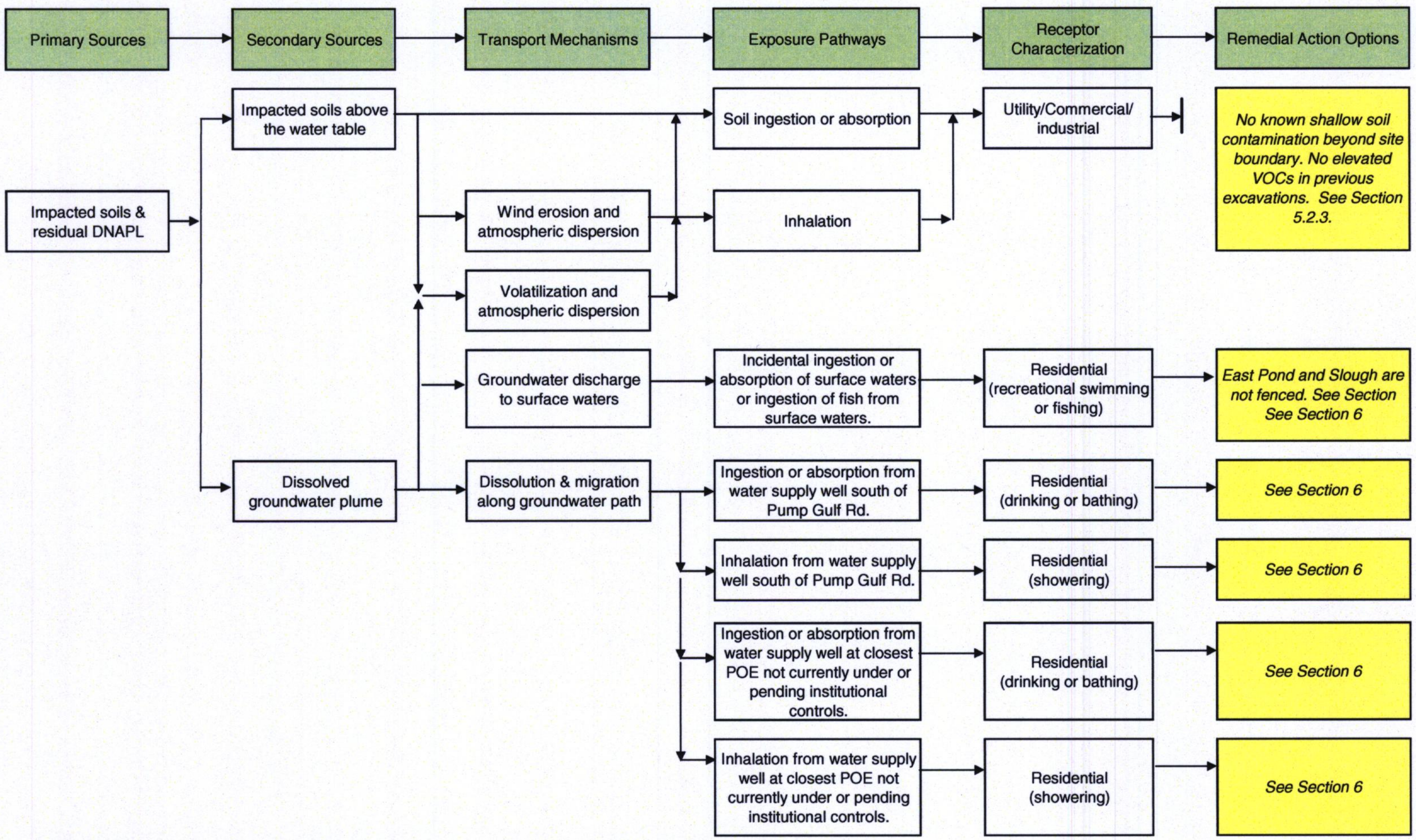
Toxicological data used in this toxicity assessment were obtained exclusively from the EPA IRIS database. EPA-verified slope factors or unit cancer risks found in IRIS are accompanied by EPA's weight-of-evidence classification for carcinogenicity based on the completeness of the evidence that the agent causes cancer in experimental animals and humans. The EPA employs a slope factor value at the upper 95 percent confidence limit of the range of possible slope factors. Animal data used in the linearized, multistage dose-response model used to extrapolate cancer risk are often obtained from the most sensitive species of experimental animals. The study which gives the highest level of extrapolated risks (when more than one study is available) is used to derive potential human doses, with a scaling factor that assumes that humans are more sensitive. These assumptions and procedures are designed to avoid underestimating risk, and the greater the uncertainty, the more the results are biased toward higher carcinogenic risks.

Figure D-1A
Conceptual Site Risk Model, INT West Plumes



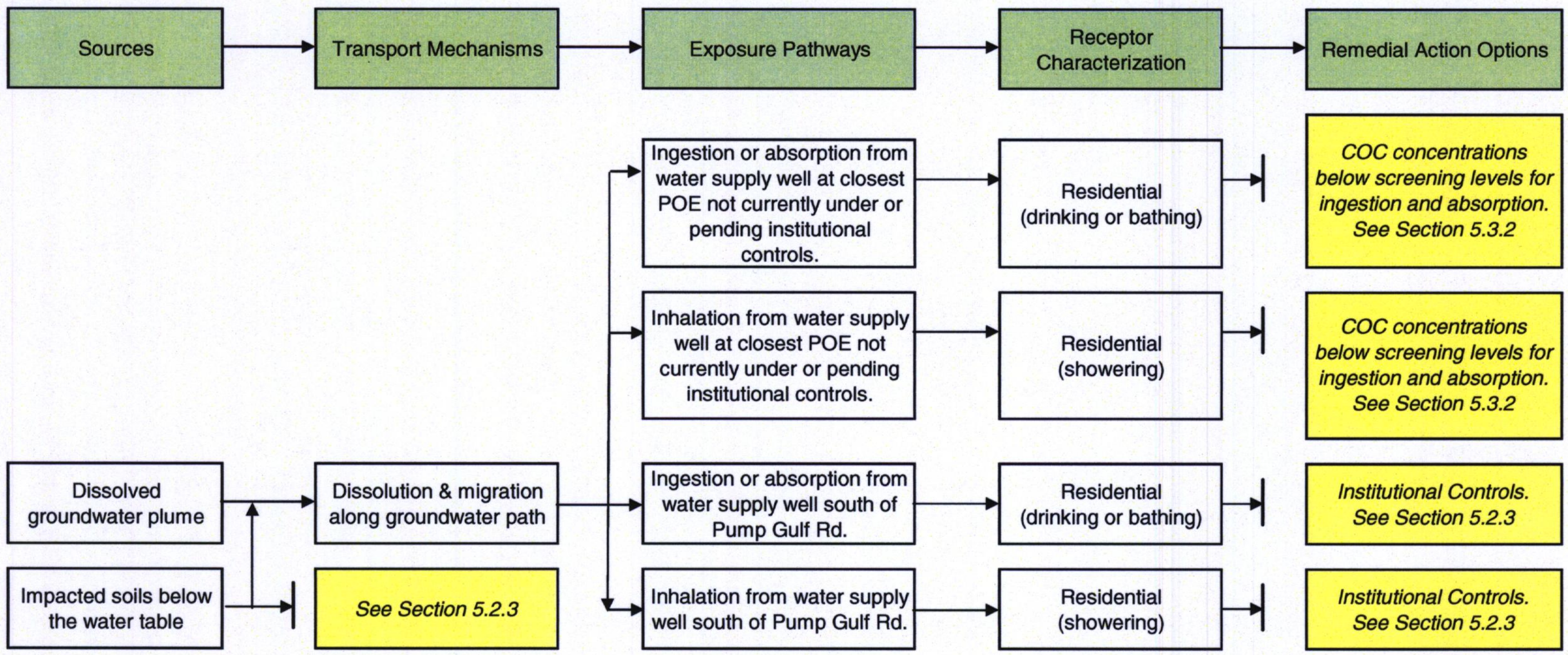
1. A continuous arrow indicates an actual or imminent exposure pathway. A blocked arrow indicates an incomplete pathway.
2. The Conceptual Site Model is modified from the *Exposure Evaluation Flowchart* (Figures X5.1 and X5.2) presented in ATSM's *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (ASTM E 1739-95)

Figure D-1B
Conceptual Site Risk Model, S1 East Plume

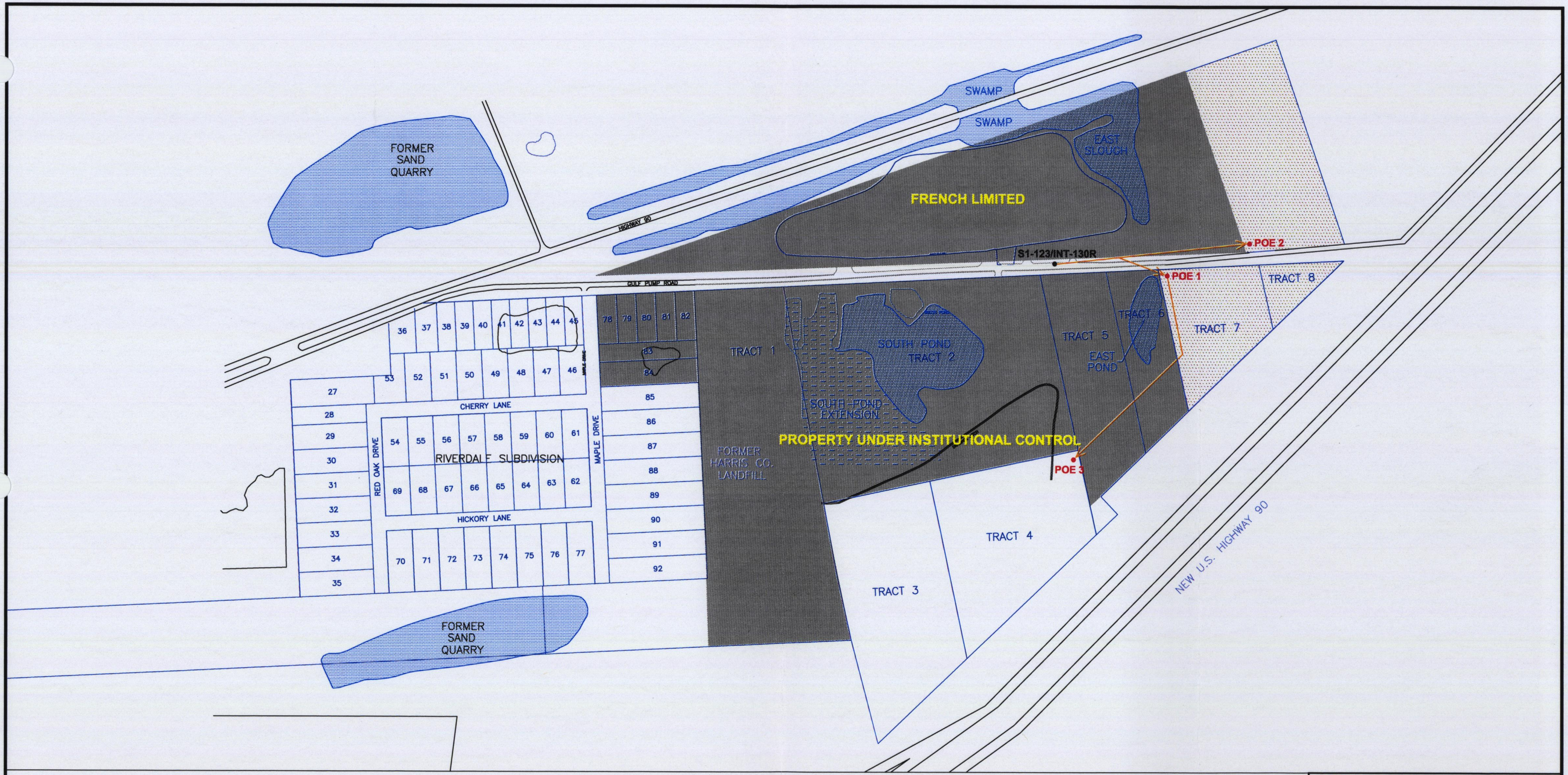


1. A continuous arrow indicates an actual or imminent exposure pathway. A blocked arrow indicates an incomplete pathway.
2. The Conceptual Site Model is modified from the *Exposure Evaluation Flowchart* (Figures X5.1 and X5.2) presented in ATSM's *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (ASTM E 1739-95)

Figure D-1C
Conceptual Site Risk Model, INT East Plume



1. A continuous arrow indicates an actual or imminent exposure pathway. A blocked arrow indicates an incomplete pathway.
2. The Conceptual Site Model is modified from the *Exposure Evaluation Flowchart* (Figures X5.1 and X5.2) presented in ATSM's *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (ASTM E 1739-95)



LEGEND

- POE LOCATIONS (HYPOTHETICAL POINT OF EXPOSURE WELL)
- MIGRATION PATHS
- PROPERTY UNDER CURRENT FRENCH CONTROL
- PROPERTY FOR WHICH INSTITUTIONAL CONTROLS ARE CURRENTLY PURSUED

250' 0 250'
SCALE IN FEET

Applied Hydrology Associates, Inc.

FLTG.,Inc.
FRENCH LIMITED SITE
CROSBY, TEXAS

FIGURE D-2
FRENCH PROPERTY UNDER INSTITUTIONAL CONTROL & POE LOCATIONS

DESIGN: TWG	DATE: 1/10/02	DRAWING NUMBER
DRAWN: JLS	SCALE: AS SHOWN	POE Locations.dwg
SCRIPT:		

TABLE D-1a
SELECTION OF EXPOSURE PATHWAYS
FRENCH LIMITED SITE - WEST INT AREA

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
current	groundwater	groundwater	Tap water from well in the INT unit in the West Plumes Area South of Gulf Pump Road	Hypothetical esident located south of Gulf Pump Road	not documented	ingestion and dermal	qualitative	Institutional Control in place to prevent use of shallow groundwater and concentrations expected to be below MCLs by 2025
current	groundwater	vapor	Vapors from showering with water from well in the INT unit in the West Plumes Area South of Gulf Pump Road	Hypothetical resident located south of Gulf Pump Road	not documented	inhalation	qualitative	Institutional Control in place to prevent use of shallow groundwater and concentrations expected to be below MCLs by 2025

TABLE D-1b
SELECTION OF EXPOSURE PATHWAYS
FRENCH LIMITED SITE - EAST S1 AREA

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
current/ future	groundwater	groundwater	Tap water from well in S1 immediately south of Gulf Pump Road	Hypothetical resident on South Side of Gulf Pump Road	not documented	ingestion and dermal	qualitative	Long-term Institutional Control required to prevent installation of water supply well in S1 Unit
current/ future	groundwater	vapor	Vapors from showering with water from well in S1 immediately south of Gulf PumpRoad	Hypothetical resident on South Side of Gulf Pump Road	not documented	inhalation	qualitative	Long-term Institutional Control required to prevent installation of water supply well in S1 Unit
Future	groundwater	Surface Water	Dermal Contact from swimming in East Pond or East Slough	swimmer	Adult & Child	dermal	quantative	
Future	groundwater	Fish	Ingestion of fish from East Pond or East Slough	fisherman	Adult & Child	ingestion	quantative	
Future	groundwater	groundwater	Tap water from well in S1 at closest POE not currently under or pending institutional control	Hypothetical resident at POE-3	Adult & Child	ingestion and dermal	quantative	
Future	groundwater	vapor	Vapors from showering with water from well in S1 at closest POE not currently under or pending institutional control	Hypothetical resident at POE-3	Adult & Child	inhalation	quantative	

TABLE D-1c

SELECTION OF EXPOSURE PATHWAYS

FRENCH LIMITED SITE - EAST INT AREA

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
current/ future	groundwater	groundwater	Tap water from well in INT immediately south of Gulf Pump Road	Hypothetical resident on South Side of Gulf Pump Road	not documented	ingestion and dermal	qualitative	Long-term Institutional Control required to prevent installation of water supply well in INT Unit
current/ future	groundwater	vapor	Vapors from showering with water from well in INT immediately south of Gulf PumpRoad	Hypothetical resident on South Side of Gulf Pump Road	not documented	inhalation	qualitative	Long-term Institutional Control required to prevent installation of water supply well in INT Unit
Future	groundwater	groundwater	Tap water from well in INT at closest POE not currently under or pending institutional control	Hypothetical resident at POE-3	Adult & Child	ingestion and dermal	quantative	
Future	groundwater	vapor	Vapors from showering with water from well in INT at closest POE not currently under or pending institutional control	Hypothetical resident at POE-3	Adult & Child	inhalation	quantative	

TABLE D.2.1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - WEST INT AREA

Scenario Timeframe:	CURRENT (2002)
Medium:	GROUNDWATER
Exposure Medium:	GROUNDWATER

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Tap water from well in the INT unit in the West Plumes Area South of Gulf Pump Road	75-34-3	1,1-DICHLOROETHANE	1 J	60	µg/l	INT-252	23/38	5	60	NA	2400 N	3500	CC	N	BSL
	107-06-2	1,2-DICHLOROETHANE	1 J	30	µg/l	INT-134	17/38	5	30	NA	5 M	5	CC	Y	ASL
	156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	1 J	46	µg/l	INT-252	20/38	5	46	NA	100 M	100	CC	N	BSL
	78-87-5	1,2-DICHLOROPROPANE	2 J	2 J	µg/l	INT-134 / INT-250	4/38	5	2	NA	5 M	5	MCL	N	BSL
	67-64-1	ACETONE	5	5	µg/l	INT-252	1/38	5	5	NA	2400 N			N	BSL
	7440-38-2	ARSENIC	38	38	µg/l	INT-135	1/2	10	38	38	38 BAC	10	MCL	N	BAC
	71-43-2	BENZENE	1 J	270	µg/l	INT-026	15/38	5	270	NA	5 M	5	CC	Y	ASL
	56-23-5	CARBON TETRACHLORIDE	2 J	3 J	µg/l	INT-149	2/38	5	3	NA	5 M	5	CC	N	BSL
	108-90-7	CHLOROBENZENE	1 J	5	µg/l	INT-026	14/38	5	5	NA	100 M	100	MCL	N	BSL
	75-00-3	CHLOROETHANE	1 J	2 J	µg/l	INT-250	3/38	5	2	NA	9800 N	10	CC	N	BSL
	67-66-3	CHLOROFORM	1 J	13	µg/l	INT-254	15/38	5	13	NA	100 M	100	CC	N	BSL
	156-59-2	CIS-1,2-DICHLOROETHENE	1 J	4 J	µg/l	INT-250	10/38	5	4	NA	70 M	70	MCL	N	BSL
	100-41-4	ETHYLBENZENE	1 J	3 J	µg/l	INT-026	4/38	5	3	NA	700 M	700	CC	N	BSL
	91-20-3	NAPHTHALENE	1 J	1 J	µg/l	INT-026 / INT-253	2/38	10	1	NA	490 N	490	MCL	N	BSL
	127-18-4	TETRACHLOROETHENE	1 J	4 J	µg/l	INT-254	7/38	5	4	NA	5 M	5	CC	N	BSL
	108-88-3	TOLUENE	1 J	2 J	µg/l	INT-026	3/38	5	2	NA	1000 M	1000	CC	N	BSL
	156-60-5	TRANS-1,2-DICHLOROETHENE	1 J	44	µg/l	INT-252	18/38	5	44	NA	100 M	100	MCL	N	BSL
	79-01-6	TRICHLOROETHENE	1 J	2 J	µg/l	INT-254	4/38	5	2	NA	5 M	5	CC	N	BSL
	75-01-4	VINYL CHLORIDE	1 J	150	µg/l	INT-252	24/38	2 - 5	150	NA	2 M	2	CC	Y	ASL
	1330-20-7	XYLENE(TOTAL)	10 J	14 J	µg/l	INT-025	2/38	5	14	NA	10000 M	10000	CC	N	BSL

(1) Maximum Concentration used for screening.

(2) To date, no background study has been completed

(3) Table 3 Tier 1 Groungwater PCLs: Texas Risk Reduction Program Rule
http://www.tnrcc.state.tx.us/permitting/remed/techsupp/guidance.htm
N = noncarcinogenic; M = primary MCL based; C = carcinogenic.

(4) Rational Codes:

Selection Reason: Above Screening Level (ASL)
Deletion Reason: Below Screening Level (BSL)
Deletion Reason: Background Level (BAC)

Definitions: = Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D.2.2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - WEST INT AREA

Scenario Timeframe:	CURRENT (2002)
Medium:	GROUNDWATER
Exposure Medium:	AIR

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Vapors from showering with water from well in the INT unit in the West Plumes Area South of Gulf Pump Road	75-34-3	1,1-DICHLOROETHANE	1 J	60	µg/l	INT-252	23/38	5	60	NA	930,000 N	3500	CC	N	BSL
	107-06-2	1,2-DICHLOROETHANE	1 J	30	µg/l	INT-134	17/38	5	30	NA	4300 C	5	CC	N	BSL
	156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	1 J	46	µg/l	INT-252	20/38	5	46	NA	---	100	CC	---	---
	78-87-5	1,2-DICHLOROPROPANE	2 J	2 J	µg/l	INT-134 / INT-250	4/38	5	2	NA	15000 N	5	MCL	N	BSL
	67-64-1	ACETONE	5	5	µg/l	INT-252	1/38	5	5	NA	33,000,000 N			N	BSL
	71-43-2	BENZENE	1 J	270	µg/l	INT-026	15/38	5	270	NA	6600 C	5	CC	N	BSL
	56-23-5	CARBON TETRACHLORIDE	2 J	3 J	µg/l	INT-149	2/38	5	3	NA	1000 C	5	CC	N	BSL
	108-90-7	CHLOROBENZENE	1 J	5	µg/l	INT-026	14/38	5	5	NA	180,000 N	100	MCL	N	BSL
	75-00-3	CHLOROETHANE	1 J	2 J	µg/l	INT-250	3/38	5	2	NA	15,000,000 N	10	CC	N	BSL
	67-66-3	CHLOROFORM	1 J	13	µg/l	INT-254	15/38	5	13	NA	2600 C	100	CC	N	BSL
	156-59-2	CIS-1,2-DICHLOROETHENE	1 J	4 J	µg/l	INT-250	10/38	5	4	NA	2,100,000 N	70	MCL	N	BSL
	100-41-4	ETHYLBENZENE	1 J	3 J	µg/l	INT-026	4/38	5	3	NA	2,000,000 N	700	CC	N	BSL
	91-20-3	NAPHTHALENE	1 J	1 J	µg/l	INT-026 / INT-253	2/38	10	1	NA	41,000 N	490	MCL	N	BSL
	127-18-4	TETRACHLOROETHENE	1 J	4 J	µg/l	INT-254	7/38	5	4	NA	42,000 C	5	CC	N	BSL
	108-88-3	TOLUENE	1 J	2 J	µg/l	INT-026	3/38	5	2	NA	800,000 N	1000	CC	N	BSL
	156-60-5	TRANS-1,2-DICHLOROETHENE	1 J	44	µg/l	INT-252	18/38	5	44	NA	1,300,000 N	100	MCL	N	BSL
	79-01-6	TRICHLOROETHENE	1 J	2 J	µg/l	INT-254	4/38	5	2	NA	21000 C	5	CC	N	BSL
	75-01-4	VINYL CHLORIDE	1 J	150	µg/l	INT-252	24/38	2 - 5	150	NA	470 C	2	CC	N	BSL
	1330-20-7	XYLENE(TOTAL)	10 J	14 J	µg/l	INT-026	2/38	5	14	NA	940,000 N	10000	CC	N	BSL

(1) Maximum Concentration used for screening.

(2) To date, no background study has been completed.
(3) Table 3 Tier 1 Groungwater PCLs; Texas Risk Reduction Program Rule
http://www.tnrcc.state.tx.us/permitting/remed/techsupp/guidance.htm
N = noncarcinogenic; M = primary MCL based; C = carcinogenic.

(4) Rational Codes:

Selection Reason: Above Screening Level (ASL)
Deletion Reason: Below Screening Level (BSL)

Definitions: = Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D.2.3
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST S1 AREA

Scenario Timeframe:	CURRENT (2002)
Medium:	GROUNDWATER
Exposure Medium:	GROUNDWATER

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Tap water from well in S1 immediately south of Gulf Pump Road	75-34-3	1,1-DICHLOROETHANE	2 J	61	µg/l	S1-154	17/26	5	61	NA	2400 N	3500	CC	N	BSL
	75-35-4	1,1-DICHLOROETHENE	3 J	4 J	µg/l	S1-154	3/26	5	4	NA	7 M	7	MCL	N	BSL
	107-06-2	1,2-DICHLOROETHANE	2 J	130	µg/l	S1-154	7/26	5	130	NA	5 M	5	CC	Y	ASL
	156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	1 J	241	µg/l	S1-154	13/26	5	241	NA	100 M	100	CC	Y	ASL
	71-43-2	BENZENE	2 J	240	µg/l	S1-147	12/26	5	240	NA	5 M	5	CC	Y	ASL
	56-23-5	CARBON TETRACHLORIDE	1 J	1 J	µg/l	S1-154	1/26	5	1	NA	5 M	5	CC	N	BSL
	108-90-7	CHLOROBENZENE	1 J	1 J	µg/l	S1-147	1/26	5	1	NA	100 M	100	MCL	N	BSL
	67-66-3	CHLOROFORM	1 J	22	µg/l	S1-154	11/26	5	22	NA	100 M	100	CC	N	BSL
	156-59-2	CIS-1,2-DICHLOROETHENE	1 J	210	µg/l	S1-154	12/26	5	210	NA	70 M	70	MCL	Y	ASL
	100-41-4	ETHYLBENZENE	1 J	1 J	µg/l	S1-147	2/26	5	1	NA	700 M	700	CC	N	BSL
	91-20-3	NAPHTHALENE	1 J	94	µg/l	S1-156	7/26	10	94	NA	490 N	490	MCL	N	BSL
	127-18-4	TETRACHLOROETHENE	6	45	µg/l	S1-154	10/26	5	45	NA	5 M	5	CC	Y	ASL
	108-88-3	TOLUENE	1 J	2 J	µg/l	S1-147	2/26	5	2	NA	1000 M	1000	CC	N	BSL
	156-60-5	TRANS-1,2-DICHLOROETHENE	6	30	µg/l	S1-154	6/26	5	30	NA	100 M	100	MCL	N	BSL
	79-01-6	TRICHLOROETHENE	1 J	22	µg/l	S1-154	12/26	5	22	NA	5 M	5	CC	Y	ASL
	75-01-4	VINYL CHLORIDE	2 J	57	µg/l	S1-154	6/26	2 - 5	57	NA	2 M	2	CC	Y	ASL
	1330-20-7	XYLENE(TOTAL)	1 J	12 J	µg/l	S1-147	4/26	5	12	NA	10000 M	10000	CC	N	BSL

(1) Maximum Concentration used for screening
(2) To date, no background study has been completed
(3) Table 3 Tier 1 Groungwater PCLs, Texas Risk Reduction Program Rule
http://www.tnrcc.state.tx.us/permitting/remed/techsupp/guidance.htm
N = noncarcinogenic, M = primary MCL based, C = carcinogenic.

Definitions: = Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D 2.4
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST S1 AREA

Scenario Timeframe:	CURRENT (2002)
Medium.	GROUNDWATER
Exposure Medium:	AIR

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Vapors from showering with water from well in S1 immediately south of Gulf PumpRoad	75-34-3	1,1-DICHLOROETHANE	2 J	61	µg/l	S1-154	17/26	5	61	NA	930,000 N	3500	CC	N	BSL
	75-35-4	1,1-DICHLOROETHENE	3 J	4 J	µg/l	S1-154	3/26	5	4	NA	30000 C	7	MCL	N	BSL
	107-06-2	1,2-DICHLOROETHANE	2 J	130	µg/l	S1-154	7/26	5	130	NA	4300 C	5	CC	N	BSL
	156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	1 J	241	µg/l	S1-154	13/26	5	241	NA	---	100	CC	---	---
	71-43-2	BENZENE	2 J	240	µg/l	S1-147	12/26	5	240	NA	6600 C	5	CC	N	BSL
	56-23-5	CARBON TETRACHLORIDE	1 J	1 J	µg/l	S1-154	1/26	5	1	NA	1000 C	5	CC	N	BSL
	108-90-7	CHLOROBENZENE	1 J	1 J	µg/l	S1-147	1/26	5	1	NA	180,000 N	100	MCL	N	BSL
	67-66-3	CHLOROFORM	1 J	22	µg/l	S1-154	11/26	5	22	NA	2600 C	100	CC	N	BSL
	156-59-2	CIS-1,2-DICHLOROETHENE	1 J	210	µg/l	S1-154	12/26	5	210	NA	2,100,000 N	70	MCL	N	BSL
	100-41-4	ETHYLBENZENE	1 J	1 J	µg/l	S1-147	2/26	5	1	NA	2,000,000 N	700	CC	N	BSL
	91-20-3	NAPHTHALENE	1 J	94	µg/l	S1-156	7/26	10	94	NA	41,000 N	490	MCL	N	BSL
	127-18-4	TETRACHLOROETHENE	6	45	µg/l	S1-154	10/26	5	45	NA	42,000 C	5	CC	N	BSL
	108-88-3	TOLUENE	1 J	2 J	µg/l	S1-147	2/26	5	2	NA	800,000 N	1000	CC	N	BSL
	156-60-5	TRANS-1,2-DICHLOROETHENE	6	30	µg/l	S1-154	6/26	5	30	NA	1,300,000 N	100	MCL	N	BSL
	79-01-6	TRICHLOROETHENE	1 J	22	µg/l	S1-154	12/26	5	22	NA	21000 C	5	CC	N	BSL
	75-01-4	VINYL CHLORIDE	2 J	57	µg/l	S1-154	6/26	2 - 5	57	NA	470 C	2	CC	N	BSL
	1330-20-7	XYLENE(TOTAL)	1 J	12 J	µg/l	S1-147	4/26	5	12	NA	940 000 N	10000	CC	N	BSL

(1) Maximum Concentration used for screening.
(2) To date, no background study has been completed.
(3) Table 3 Tier 1 Groungwater PCLs; Texas Risk Reduction Program Rule
http://www.tnrcc.state.tx.us/permitting/remed/techsupp/guidance.htm
N = noncarcinogenic; M = primary MCL based; C = carcinogenic.

Definitions: = Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D.2.5
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST POND or EAST SLOUGH FROM EAST PLUME AREA

Scenario Timeframe:	FUTURE (2050)
Medium:	GROUNDWATER
Exposure Medium:	SURFACE WATER

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N) (3)	Screening Toxicity Value (C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source (4)	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Dermal Contact and Injestion from swimming in East Pond or East Slough	107-06-2	1,2-DICHLOROETHANE	NA	125 modeled	µg/l	EAST POND	modeled	NA	125	NA	NA	1.45E+03	5	TSWC	Y	AR
	127-18-4	TETRACHLOROETHENE	NA	2 modeled	µg/l	EAST POND	modeled	NA	2	NA	9.45E+04	2.54E+03	5	TSWC	N	BSL
	79-01-6	TRICHLOROETHENE	NA	6 modeled	µg/l	EAST POND	modeled	NA	6	NA	1.87E+03	1.99E+03	5	TSWC	Y	AR
	156-59-2	CIS-1,2-DICHLOROETHENE	NA	2 modeled	µg/l	EAST POND	modeled	NA	2	NA	9.45E+04	NA	70	MCL	N	BSL
	75-01-4	VINYL CHLORIDE	NA	2 modeled	µg/l	EAST POND	modeled	NA	4.8	NA	5.66E+03	9.43E+01	2	TSWC	Y	AR

(1) Future estimated maximum concentration used for screening using te <1/60 rule.
(2) To date, no background study has been completed.
(3) Risk Assesment Information System, updated November 2002
http://risk.lsd.ornl.gov/prg/equations/rec_wat_nrad_tot shtml

(4) Texas Surface Water Criteria for Fresh Waters Used for Protection of Human Health Table 3. (http://www.tnrcc.state.tx.us/oprd/rules/pdflib/307%60.pdf)

(5) Rational Codes:
Selection Reason: Above Screening Level (ASL); Above ARAR (AR)
Deletion Reason: Below Screening Level (BSL)

Definitions: = Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D.2.5a

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

FRENCH LIMITED SITE - EAST POND FROM EAST PLUME AREA

Incidental Ingestion and Dermal Contact simultaneously, Nonradionuclide, Recreational Land Use, Surface Water:

$$C = \frac{T \times BW \times AT}{EF \times ED \times [(TV_o \times IR \times ET) + (TV_{ad} \times SA \times K_p \times ET \times CF)]}$$

CAS Number	Chemical	Kp cm/hr	RfDad mg/kg-day Chronic	RfDo mg/kg-day Chronic	SFad ((mg/kg-day)-1)	SFo ((mg/kg-day)-1)	TV ad (C) =SF ad	TV ad (N) =1/RfDad	TV o (C) =SF o	TV o (N) =1/RfDo	T (C) =TR	T (N) =THI	C (C) mg/L	C (N) mg/L	C (C) ug/L	C (N) ug/L
107-06-2	1,2-DICHLOROETHANE	0.00534	NA	NA	9.10E-02	9.10E-02	9.10E-02	NA	9.10E-02	NA	1.00E-06	1.00E+00	1.45E+00	NA	1.45E+03	NA
156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	0.0149	NA	NA	NA	NA	NA	NA	NA	NA	1.00E-06	1.00E+00	NA	NA	NA	NA
67-66-3	CHLOROFORM	0.00892	2.00E-03	1.00E-02	3.05E-02	6.10E-03	3.05E-02	5.00E+02	6.10E-03	1.00E+02	1.00E-06	1.00E+00	4.75E+00	1.24E+02	4.75E+03	1.24E+05
156-59-2	CIS-1,2-DICHLOROETHENE	0.0149	1.00E-01	1.00E-02	NA	NA	NA	1.00E+01	NA	1.00E+02	1.00E-06	1.00E+00	NA	2.83E+03	NA	2.83E+06
100-41-4	ETHYLBENZENE	0.0739	9.70E-02	1.00E-01	NA	NA	NA	1.03E+01	NA	1.00E+01	1.00E-06	1.00E+00	NA	5.51E+03	NA	5.51E+06
91-20-3	NAPHTHALENE	0.0694	1.60E-02	2.00E-02	NA	NA	NA	6.25E+01	NA	5.00E+01	1.00E-06	1.00E+00	NA	9.26E+02	NA	9.26E+05
127-18-4	TETRACHLOROETHENE	0.0481	1.00E-01	1.00E-02	5.20E-02	5.20E-02	5.20E-02	1.00E+01	5.20E-02	1.00E+02	1.00E-06	1.00E+00	2.54E+00	2.83E+03	2.54E+03	2.83E+06
108-88-3	TOLUENE	0.0453	1.60E-01	2.00E-01	NA	NA	NA	6.25E+00	NA	5.00E+00	1.00E-06	1.00E+00	NA	9.26E+03	NA	9.26E+06
156-60-5	TRANS-1,2-DICHLOROETHENE	0.0149	2.00E-01	2.00E-02	NA	NA	NA	5.00E+00	NA	5.00E+01	1.00E-06	1.00E+00	NA	5.67E+03	NA	5.67E+06
79-01-6	TRICHLOROETHENE	0.0157	9.00E-04	6.00E-03	7.33E-02	1.10E-02	7.33E-02	1.11E+03	1.10E-02	1.67E+02	1.00E-06	1.00E+00	1.99E+00	5.62E+01	1.99E+03	5.62E+04
75-01-4	VINYL CHLORIDE	0.0113	3.00E-03	3.00E-03	1.40E+00	1.40E+00	1.40E+00	3.33E+02	1.40E+00	3.33E+02	1.00E-06	1.00E+00	9.43E-02	1.70E+02	9.43E+01	1.70E+05
1330-20-7	XYLENE(TOTAL)	0.0704	1.84E+00	2.00E+00	NA	NA	NA	5.43E-01	NA	5.00E-01	1.00E-06	1.00E+00	NA	1.05E+05	NA	1.05E+08

Kp, RfD & Sf values from Risk Assessment Information System, Oak Ridge National Laboratory. Toxicity values were updated in November 2002 from EPA's IRIS and HEAST databases.

	Notes	Value	unit	
AT (N)	ED*365	10950	yrxday/yr	United States Environmental Protection Agency. 1991. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Office of Emergency and Remedial Response, Washington, D.C.
AT (C)	70x365	25,550	yrxday/yr	United States Environmental Protection Agency. 1991. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Office of Emergency and Remedial Response, Washington, D.C.
BW	Adult body weight.	70	kg	United States Environmental Protection Agency. 1991. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Office of Emergency and Remedial Response, Washington, D.C.
CF	Unit conversion factor	10	L/cm-m2	
ED	Exposure duration	30	yr	United States Environmental Protection Agency. 1991. Risk Assessment Guidance for Superfund Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Office of Emergency and Remedial Response, Washington, D.C.
EF	Exposure frequency	1	day/yr	See Section 5.
ET	Exposure time	1	hr/day	United States Environmental Protection Agency. 1992 Dermal Exposure Assessment: Principles and Application. Interim Report. EPA/600/8-91/011B. Office of Research and Development, Washington, D.C.
FI	Fraction ingested	1	unitless	Maximum value used; equivalent to 100%
IR	Water ingestion rate.	0.05	L/hr	United States Environmental Protection Agency. 1995. Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment (Interim Guidance). Waste Management Division, Office of Health Assessment.
SA	Adult surface area.	1.94	m2	United States Environmental Protection Agency. 1992. Dermal Exposure Assessment. Principles and Application. Interim Report. EPA/600/8-91/011B. Office of Research and Development, Washington, D.C.
TR	Target excess individual lifetime cancer risk.	0.000001	unitless	
TR	Target excess individual lifetime cancer risk	0.0001	unitless	
THI	Target hazard index.	1	unitless	
THI	Target hazard index.	0.01	unitless	

TABLE D.2.6
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST POND FROM EAST PLUME AREA

Scenario Timeframe:	FUTURE (2050)
Medium:	GROUNDWATER
Exposure Medium:	FISH

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N) (3)	Screening Toxicity Value (C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source (4)	Rationale for Selection or Deletion (5)
Ingestion of fish from East Pond or East Slough	107-06-2	1,2-DICHLOROETHANE	NA	125 modeled	µg/l	EAST POND	modeled	NA	125	NA	NA	1.01E+03	73.9	TSWC	AR
	127-18-4	TETRACHLOROETHENE	NA	2 modeled	µg/l	EAST POND	modeled	NA	2	NA	3.94E+05	1.77E+03	323	TSWC	BSL
	79-01-6	TRICHLOROETHENE	NA	6 modeled	µg/l	EAST POND	modeled	NA	6	NA	2.37E+05	8.36E+03	612	TSWC	BSL
	156-59-2	CIS-1,2-DICHLOROETHENE	NA	2 modeled	µg/l	EAST POND	modeled	NA	2	NA	3.94E+05	NA	70	MCL	BSL
	75-01-4	VINYL CHLORIDE	NA	2 modeled	µg/l	EAST POND	modeled	NA	2	NA	1.18E+05	6.57E+01	415	TSWC	BSL

(1) Maximum Concentration used for screening.
(2) To date, no background study has been completed.
(3) Risk Assesment Information System, updated November 2002
http://risk.lsd.ornl.gov/prg/equations/rec_wat_nrad_ing_1.shtml
(4) Texas Surface Water Criteria for Fresh Waters Used for Protection of Human Health Table 3. (http://www.tnrcc.state.tx.us/oprd/rules/pdflib/307%60 pdf)

(5) Rational Codes:
Selection Reason: Above Screening Level (ASL); Above ARAR (AR)
Deletion Reason: Below Screening Level (BSL)

Definitions: = Estimated Value
D = Diluted Sample

J = Estimated Value

NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D.2 6a
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST POND FROM EAST PLUME AREA

Fish Ingestion, Nonradionuclide, Recreational Land Use, Surface Water:

$$C = \frac{T \times BW \times AT}{TV \times IR \times FI \times EF \times ED}$$

CAS Number	Chemical	Kp cm/hr	RfDo mg/kg-day Chronic	SFo mg/ky-day)-	TV o (N) =1/RfDo	T (C) =TR	T (N) =THI	C (C) mg/L	C (N) mg/L	C (C) ug/L	C (N) ug/L
107-06-2	1,2-DICHLOROETHANE	0.00534	NA	9.10E-02	NA	1.00E-06	1.00E+00	1.01E+00	NA	1.01E+03	NA
156-59-2	CIS-1,2-DICHLOROETHENE	0 0149	1.00E-02	NA	1.00E+02	1.00E-06	1.00E+00	NA	3 94E+02	NA	3.94E+05
127-18-4	TETRACHLOROETHENE	0.0481	1.00E-02	5 20E-02	1 00E+02	1.00E-06	1.00E+00	1.77E+00	3.94E+02	1.77E+03	3.94E+05
79-01-6	TRICHLOROETHENE	0.0157	6.00E-03	1.10E-02	1.67E+02	1.00E-06	1.00E+00	8.36E+00	2.37E+02	8.36E+03	2.37E+05
75-01-4	VINYL CHLORIDE	0 0113	3.00E-03	1.40E+00	3.33E+02	1.00E-06	1.00E+00	6.57E-02	1.18E+02	6.57E+01	1.18E+05

RfDo & Sfo values from Risk Assessment Information System, Oak Ridge National Laboratory. Toxicity values were updated on November 2002 from EPA's IRIS and HEAST databases.

Constants	Notes	Value	unit	Source
AT (N)	ED*365	10,950	yrxday/yr	Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Office of Emergency and Remedial Response, Washington, D.C.
AT (C)	70*365	25,550	yrxday/yr	Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Office of Emergency and Remedial Response, Washington, D C.
BW	Adult body weight	70	kg	Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Office of Emergency and Remedial Response, Washington, D C.
ED	Exposure duration.	30	yr	Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Office of Emergency and Remedial Response, Washington, D.C.
EF	Exposure frequency	12	day/yr	See Section 5
FI	Fraction ingested.	1	unitless	Maximum value used; equivalent to 100%
IR	Fish ingestion rate.	0.054	L/hr	Human Health Evaluation Manual Supplemental Guidance Standard Default Exposure Factors. OSWER Directive 9285 6-03. Office of Emergency and Remedial Response, Washington, D.C.
TR	Target excess individual lifetime cancer risk.	0.000001	unitless	
TR	Target excess individual lifetime cancer risk.	0.0001	unitless	
THI	Target hazard index.	1	unitless	
THI	Target hazard index.	0.01	unitless	

TABLE D 2 7
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST S1 AREA

Scenario Timeframe:	FUTURE (2050)
Medium:	GROUNDWATER
Exposure Medium:	GROUNDWATER

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Tap water from well in S1 at closest POE not currently under or pending institutional control	107-06-2	1,2-DICHLOROETHANE	NA	<1 modeled	µg/l	POE 3	modeled	NA	1	NA	5 M	5	CC	N	BSL
	156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	NA	<1 modeled	µg/l	POE 3	modeled	NA	1	NA	100 M	100	CC	N	BSL
	71-43-2	BENZENE	NA	0 modeled	µg/l	POE 3	modeled	NA	0	NA	5 M	5	CC	N	BSL
	156-59-2	CIS-1,2-DICHLOROETHENE	NA	<1 modeled	µg/l	POE 3	modeled	NA	1	NA	70 M	70	MCL	N	BSL
	127-18-4	TETRACHLOROETHENE	NA	<1 modeled	µg/l	POE 3	modeled	NA	1	NA	5 M	5	CC	N	BSL
	79-01-6	TRICHLOROETHENE	NA	1 modeled	µg/l	POE 3	modeled	NA	1	NA	5 M	5	CC	N	BSL
	75-01-4	VINYL CHLORIDE	NA	<1 modeled	µg/l	POE 3	modeled	NA	1	NA	2 M	2	CC	N	BSL

(1) Maximum Concentration used for screening.
(2) To date, no background study has been completed.
(3) Table 3 Tier 1 Groungwater PCLs: Texas Risk Reduction Program Rule
http://www.tnrcc.state.tx.us/permitting/remed/techsupp/guidance.htm
N = noncarcinogenic; M = primary MCL based; C = carcinogenic.
(4) Rational Codes:
Selection Reason: Above Screening Level (ASL)
Deletion Reason: Below Screening Level (BSL)

Definitions: = Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D.2.8
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST S1 AREA

Scenario Timeframe:	FUTURE (2050)
Medium:	GROUNDWATER
Exposure Medium:	AIR

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier) Modeled	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Vapors from showering with water from well in S1 at closest POE not currently under or pending institutional control	107-06-2	1,2-DICHLOROETHANE	NA	<1 modeled	µg/l	POE 3	modeled	NA	1	NA	4300 C	5	CC	N	BSL
	156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	NA	<1 modeled	µg/l	POE 3	modeled	NA	1	NA	---	100	CC	---	---
	71-43-2	BENZENE	NA	0 modeled	µg/l	POE 3	modeled	NA	0	NA	6600 C	5	CC	N	BSL
	156-59-2	CIS-1,2-DICHLOROETHENE	NA	<1 modeled	µg/l	POE 3	modeled	NA	1	NA	2,100,000 N	70	MCL	N	BSL
	127-18-4	TETRACHLOROETHENE	NA	<1 modeled	µg/l	POE 3	modeled	NA	1	NA	42,000 C	5	CC	N	BSL
	79-01-6	TRICHLOROETHENE	NA	1 modeled	µg/l	POE 3	modeled	NA	1	NA	21,000 C	5	CC	N	BSL
	75-01-4	VINYL CHLORIDE	NA	<1 modeled	µg/l	POE 3	modeled	NA	1	NA	470 C	2	CC	N	BSL

(1) Maximum Concentration used for screening
(2) To date, no background study has been completed.
(3) Table 3 Tier 1 Groungwater PCLs; Texas Risk Reduction Program Rule
http://www.tnrcc.state.tx.us/permitting/remed/techsupp/guidance.htm
N = noncarcinogenic; M = primary MCL based; C = carcinogenic.

Definitions: = Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D.2.9
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST INT AREA

Scenario Timeframe:	CURRENT (2002)
Medium:	GROUNDWATER
Exposure Medium	GROUNDWATER

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Tap water from well in INT immediately south of Gulf Pump Road	75-34-3	1,1-DICHLOROETHANE	3 J	1600	µg/l	INT-236	11/15	5	1600	NA	2400 N	3500	CC	N	BSL
	107-06-2	1,2-DICHLOROETHANE	12	26,000	µg/l	INT-236	8/15	5	26000	NA	5 M	5	CC	Y	ASL
	156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	1 J	10200	µg/l	INT-236	9/15	5	10200	NA	100 M	100	CC	Y	ASL
	108-10-1	4-METHYL-2-PENTANONE	9	9	µg/l	INT-154	1/15	5 - 1000	9	NA	1700 M	1700	CC	N	BSL
	67-64-1	ACETONE	500	500	µg/l	INT-236	1/15	5 - 1000	500	NA	2400 N	NA	NA	N	BSL
	71-43-2	BENZENE	2 J	230 D	µg/l	INT-154	8/15	5 - 1000	230	NA	5 M	5	CC	Y	ASL
	56-23-5	CARBON TETRACHLORIDE	470 D	3300	µg/l	INT-236	4/15	5	3300	NA	5 M	5	CC	Y	ASL
	108-90-7	CHLOROBENZENE	2 J	2 J	µg/l	INT-154	1/15	5 - 1000	2	NA	100 M	100	MCL	N	BSL
	75-00-3	CHLOROETHANE	2 J	2 J	µg/l	INT-154	2/15	5 - 1000	2	NA	10 M	10	CC	N	BSL
	67-66-3	CHLOROFORM	1 J	74000 D	µg/l	INT-236	11/15	5	74000	NA	100 M	100	CC	Y	BSL
	156-59-2	CIS-1,2-DICHLOROETHENE	1 J	8300	µg/l	INT-236	9/15	5	8300	NA	70 M	70	MCL	N	BSL
	100-41-4	ETHYLBENZENE	2 J	2 J	µg/l	INT-154	1/15	5 - 1000	2	NA	700 M	700	CC	N	BSL
	75-09-2	METHYLENE CHLORIDE	1 J	470 J	µg/l	INT-236	3/15	5	470	NA	5 M	5	CC	Y	ASL
	91-20-3	NAPHTHALENE	2 J	1800 J	µg/l	INT-236	5/15	10	1800	NA	490 N	490	MCL	Y	ASL
	127-18-4	TETRACHLOROETHENE	2 J	5500	µg/l	INT-236	10/15	5	5500	NA	5 M	5	CC	Y	ASL
	108-88-3	TOLUENE	2 J	2 J	µg/l	INT-154	5/15	5 - 1000	2	NA	1000 M	1000	CC	N	BSL
	156-60-5	TRANS-1,2-DICHLOROETHENE	J	1900	µg/l	INT-236	5/15	5	1900	NA	100 M	100	MCL	Y	ASL
	79-01-6	TRICHLOROETHENE	1 J	1800	µg/l	INT-236	10/15	5	1800	NA	5 M	5	CC	Y	ASL
	75-01-4	VINYL CHLORIDE	1 J	230 J	µg/l	INT-236	9/15	2 - 5	230	NA	2 M	2	CC	Y	ASL
	1330-20-7	XYLENE(TOTAL)	1 J	100 J	µg/l	INT-236	6/15	5 - 1000	100	NA	10000 M	10000	CC	N	BSL

(1) Maximum Concentration used for screening.
(2) To date, no background study has been completed.
(3) Table 3 Tier 1 Groungwater PCLs; Texas Risk Reduction Program Rule
http://www.tnrcc.state.tx.us/permitting/remed/techsupp/guidance.htm
N = noncarcinogenic; M = primary MCL based; C = carcinogenic.

Definitions: = Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D.2.10
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST INT AREA

Scenario Timeframe:	CURRENT (2002)
Medium:	GROUNDWATER
Exposure Medium:	AIR

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Vapors from showering with water from well in INT immediately south of Gulf PumpRoad	75-34-3	1,1-DICHLOROETHANE	3 J	1600	µg/l	INT-236	11/15	5	1600	NA	930,000 N	3500	CC	N	BSL
	107-06-2	1,2-DICHLOROETHANE	12	26,000	µg/l	INT-236	8/15	5	26000	NA	4300 C	5	CC	Y	ASL
	156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	1 J	10200	µg/l	INT-236	9/15	5	10200	NA	---	100	CC	---	---
	108-10-1	4-METHYL-2-PENTANONE	9	9	µg/l	INT-154	1/15	5 - 1000	9	NA	5,900,000 N	1700	CC	N	BSL
	67-64-1	ACETONE	500	500	µg/l	INT-236	1/15	5 - 1000	500	NA	33,000,000 N			N	BSL
	71-43-2	BENZENE	2 J	230 D	µg/l	INT-154	8/15	5 - 1000	230	NA	6600 C	5	CC	N	BSL
	56-23-5	CARBON TETRACHLORIDE	470 D	3300	µg/l	INT-236	4/15	5	3300	NA	1000 C	5	CC	Y	ASL
	108-90-7	CHLOROBENZENE	2 J	2 J	µg/l	INT-154	1/15	5 - 1000	2	NA	180,000 N	100	MCL	N	BSL
	75-00-3	CHLOROETHANE	2 J	2 J	µg/l	INT-154	2/15	5 - 1000	2	NA	15,000,000 N	10	CC	N	BSL
	67-66-3	CHLOROFORM	1 J	74000 D	µg/l	INT-236	11/15	5	74000	NA	2600 C	100	CC	Y	ASL
	156-59-2	CIS-1,2-DICHLOROETHENE	1 J	8300	µg/l	INT-236	9/15	5	8300	NA	2,100,000 N	70	MCL	N	BSL
	100-41-4	ETHYLBENZENE	2 J	2 J	µg/l	INT-154	1/15	5 - 1000	2	NA	2,000,000 N	700	CC	N	BSL
	75-09-2	METHYLENE CHLORIDE	1 J	470 J	µg/l	INT-236	3/15	5	470	NA	160,000 C	5	CC	N	BSL
	91-20-3	NAPHTHALENE	2 J	1800 J	µg/l	INT-236	5/15	10	1800	NA	41,000 N	490	MCL	N	BSL
	127-18-4	TETRACHLOROETHENE	2 J	5500	µg/l	INT-236	10/15	5	5500	NA	42,000 C	5	CC	N	BSL
	108-88-3	TOLUENE	2 J	2 J	µg/l	INT-154	5/15	5 - 1000	2	NA	800,000 N	1000	CC	N	BSL
	156-60-5	TRANS-1,2-DICHLOROETHENE	J	1900	µg/l	INT-236	5/15	5	1900	NA	1,300,000 N	100	MCL	N	BSL
	79-01-6	TRICHLOROETHENE	1 J	1800	µg/l	INT-236	10/15	5	1800	NA	21000 C	5	CC	N	BSL
	75-01-4	VINYL CHLORIDE	1 J	230 J	µg/l	INT-236	9/15	2 - 5	230	NA	470 C	2	CC	N	BSL
	1330-20-7	XYLENE(TOTAL)	1 J	100 J	µg/l	INT-236	6/15	5 - 1000	100	NA	940,000 N	10000	CC	N	BSL

(1) Maximum Concentration used for screening.
(2) To date, no background study has been completed
(3) Table 3 Tier 1 Groungwater PCLs; Texas Risk Reduction Program Rule
http://www.tnrcc.state.tx us/permitting/remed/techsupp/guidance.htm
N = noncarcinogenic; M = primary MCL based; C = carcinogenic.

Definitions:
= Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D.2.11
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST INT AREA

Scenario Timeframe:	FUTURE(2050)
Medium:	GROUNDWATER
Exposure Medium:	GROUNDWATER

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Tap water from well in INT at closest POE not currently under or pending institutional control	107-06-2	1,2-DICHLOROETHANE	NA	< 1 modeled	µg/l	POE 3	modeled	NA	1	NA	5 M	5	CC	N	BSL
	156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	NA	< 1 modeled	µg/l	POE 3	modeled	NA	1	NA	100 M	100	CC	N	BSL
	71-43-2	BENZENE	NA	0 modeled	µg/l	POE 3	modeled	NA	0	NA	5 M	5	CC	N	BSL
	56-23-5	CARBON TETRACHLORIDE	NA	0 modeled	µg/l	POE 3	modeled	NA	0	NA	5 M	5	CC	N	BSL
	67-66-3	CHLOROFORM	NA	< 1 modeled	µg/l	POE 3	modeled	NA	1	NA	100 M	100	CC	N	BSL
	75-09-2	METHYLENE CHLORIDE	NA	0 modeled	µg/l	POE 3	modeled	NA	0	NA	5 M	5	CC	N	BSL
	91-20-3	NAPHTHALENE	NA	0 modeled	µg/l	POE 3	modeled	NA	0	NA	490 N	490	MCL	N	BSL
	127-18-4	TETRACHLOROETHENE	NA	0 modeled	µg/l	POE 3	modeled	NA	0	NA	5 M	5	CC	N	BSL
	156-59-2	CIS-1,2-DICHLOROETHENE	NA	< 1 modeled	µg/l	POE 3	modeled	NA	1	NA	70 M	70	MCL	N	BSL
	79-01-6	TRICHLOROETHENE	NA	< 1 modeled	µg/l	POE 3	modeled	NA	1	NA	5 M	5	CC	N	BSL
	75-01-4	VINYL CHLORIDE	NA	< 1 modeled	µg/l	POE 3	modeled	NA	1	NA	2 M	2	CC	N	BSL

(1) Maximum Concentration used for screening.
(2) To date, no background study has been completed.
(3) Table 3 Tier 1 Groungwater PCLs; Texas Risk Reduction Program Rule
http://www.tnrcc.state.tx.us/permitting/remed/techsupp/guidance.htm
N = noncarcinogenic; M = primary MCL based; C = carcinogenic.

Definitions: = Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D 2.12
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FRENCH LIMITED SITE - EAST INT AREA

Scenario Timeframe:	FUTURE (2050)
Medium:	GROUNDWATER
Exposure Medium:	AIR

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier) Modeled	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Vapors from showering with water from well in INT at closest POE not currently under or pending institutional control	107-06-2	1,2-DICHLOROETHANE	NA	<1 modeled	µg/l	POE 3	NA	modeled	1	NA	4300 C	5	CC	N	BSL
	156-59-2 (cis) & 156-60-5 (trans)	1,2-DICHLOROETHENE(TOTAL)	NA	<1 modeled	µg/l	POE 3	NA	modeled	1	NA	---	100	CC	---	---
	71-43-2	BENZENE	NA	0 modeled	µg/l	POE 3	NA	modeled	0	NA	6600 C	5	CC	N	BSL
	56-23-5	CARBON TETRACHLORIDE	NA	0 modeled	µg/l	POE 3	NA	modeled	0	NA	1000 C	5	CC	N	BSL
	67-66-3	CHLOROFORM	NA	<1 modeled	µg/l	POE 3	NA	modeled	1	NA	2600 C	100	CC	N	BSL
	75-09-2	METHYLENE CHLORIDE	NA	0 modeled	µg/l	POE 3	NA	modeled	0	NA	160,000 C	5	CC	N	BSL
	91-20-3	NAPHTHALENE	NA	0 modeled	µg/l	POE 3	NA	modeled	0	NA	41,000 N	490	MCL	N	BSL
	127-18-4	TETRACHLOROETHENE	NA	0 modeled	µg/l	POE 3	NA	modeled	0	NA	42,000 C	5	CC	N	BSL
	156-59-2	CIS-1,2-DICHLOROETHENE	NA	<1 modeled	µg/l	POE 3	NA	modeled	1	NA	2,100,000 N	70	MCL	N	BSL
	79-01-6	TRICHLOROETHENE	NA	<1 modeled	µg/l	POE 3	NA	modeled	1	NA	21000 C	5	CC	N	BSL
	75-01-4	VINYL CHLORIDE	NA	<1 modeled	µg/l	POE 3	NA	modeled	1	NA	470 C	2	CC	N	BSL

(1) Maximum Concentration used for screening.
(2) To date, no background study has been completed.
(3) Table 3 Tier 1 Groungwater PCLs; Texas Risk Reduction Program Rule
http://www.tnrcc.state.tx.us/permitting/remed/techsupp/guidance.htm
N = noncarcinogenic; M = primary MCL based, C = carcinogenic.

(4) Rational Codes:

Selection Reason: Above Screening Level (ASL)
Deletion Reason: Below Screening Level (BSL)

Definitions:
= Estimated Value
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available
CC = French Limited Cleanup Criteria

TABLE D.3.1 rme

EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

FRENCH LIMITED SITE - EAST POND or EAST SLOUGH FROM EAST PLUME AREA

Scenario Timeframe:	FUTURE
Medium:	SURFACE WATER
Exposure Medium:	SURFACE WATER

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
Dermal Contact and Ingestion from swimming in East Pond or East Slough	1,2-DICHLOROETHANE	µg/l	NA	NA	125 modeled	125	µg/l	maximum	Highest concentration predicted in East Pond
	TRICHLOROETHENE	µg/l	NA	NA	6 modeled	6	µg/l	maximum	
	VINYL CHLORIDE	µg/l	NA	NA	2 modeled	2	µg/l	maximum	

(1) Data non parametric therefore 95% UCL not calculated
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available

TABLE D.3.2 rme

EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

FRENCH LIMITED SITE - EAST POND or EAST SLOUGH FROM EAST PLUME AREA

Scenario Timeframe:	FUTURE
Medium:	SURFACE WATER
Exposure Medium:	FISH

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value conc. (mg/l) x Fish BCF (l/kg)	Units	Statistic (2)	Rationale
Ingestion of fish from East Pond or East Slough	1,2-DICHLOROETHANE	µg/l	NA	NA	125 modeled	0.150	mg/kg	maximum	Highest concentration predicted in East Pond

Fish Bio-Concentration Factor (BCF) - DCA = 1.2 ; VC = 1.17
(1) Data non parametric therefore 95% UCL not calculated
D = Diluted Sample
J = Estimated Value
NA = Not Applicable or Not Available

TABLE D.4.1 rme
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FRENCH LIMITED SITE - EAST POND FROM EAST PLUME AREA

Scenario Timeframe:	FUTURE
Medium:	SURFACE WATER
Exposure Medium:	SURFACE WATER

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
INGESTION	SWIMMER	ADULT	SWIMMING IN EAST POND	CW	Chemical Concentration in Water	See Table 5.3.1 converted to mg/l	mg/l	See Table 5.3.1	Chronic Daily Intake (CDI) (mg/kg/day) = CW x CR x ET x EF x ED x 1/BW x 1/AT
				CR	Contact Rate	0.5	liters/hour	EPA, 1995	
				ET	Exposure Time	1	hours/event	EPA, 1992	
				EF	Exposure Frequency	1	events/year	see text	
				ED	Exposure Duration	30	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time - Cancer	25,550	days/year	EPA, 2001	
				AT-N	Averaging Time - Non-Cancer	10,950	days/year	EPA, 2001	
		CHILD	SWIMMING IN EAST POND	CW	Chemical Concentration in Water	See Table 5.3.1 converted to mg/l	mg/l	See Table 5.3.1	Chronic Daily Intake (CDI) (mg/kg/day) = CW x CR x ET x EF x ED x 1/BW x 1/AT
				CR	Contact Rate	0.5	liters/hour	EPA, 1995	
				ET	Exposure Time	1	hours/event	EPA, 1992	
				EF	Exposure Frequency	1	events/year	see text	
				ED	Exposure Duration	6	years	EPA, 1991	
				BW	Body Weight	15	kg	EPA, 1991	
				AT-C	Averaging Time - Cancer	25,550	days/year	EPA, 2001	
				AT-N	Averaging Time - Non-Cancer	2,190	days/year	EPA, 2001	
DERMAL	SWIMMER	ADULT	SWIMMING IN EAST POND	CW	Chemical Concentration in Water	See Table 5.3.1 converted to mg/l	mg/l	See Table 5.3.1	Dermally Absorbed Dose (DAD) (mg/kg-day) = DA-event x EV x ED x EF x SA x 1/BW x 1/AT where for organic compounds, Absorbed Dose per Event (DA-event) (mg/cm2-event) = 2 FA x Kp x CW x CF x SQRT{(6 x tau-event x t-event)/pi} or DA-event = FA x Kp x CW x {(t-event/(1 + B)) + 2 x tau-event x ((1 + (3 x B) + (3 x B x B))/(1 + B)2)} and where for inorganic compounds, DA-event = Kp x CW x CF x t-event
				FA	Fraction Absorbed Water	Chemical Specific	----	EPA, 2001	
				Kp	Permeability Constant	Chemical Specific	cm/hr	EPA, 2001	
				SA	Skin Surface Area	18,000	cm2	EPA, 2001	
				tau-event	Lag Time per Event	Chemical Specific	hours/event	EPA, 2001	
				t-event	Event Duration	1	hours/event	EPA, 2001	
				B	Ratio of permeability coefficient of a compound through the stratum corneum relative to the permeability coefficient across the viable epidermis	Chemical Specific	---	EPA, 2001	
				EV	Event Frequency	1	events/day	EPA, 2001	
				EF	Exposure Frequency	1	days/year	see text	
				ED	Exposure Duration	30	years	EPA, 1991	

TABLE D.4.1 rme
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FRENCH LIMITED SITE - EAST POND FROM EAST PLUME AREA

Scenario Timeframe:	FUTURE
Medium:	SURFACE WATER
Exposure Medium:	SURFACE WATER

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
DERMAL (continued)	SWIMMER (continued)	ADULT (continued)	SWIMMING IN EAST POND	CF	Volumetric Conversion Factor for Water	0.001	l/cm3	---	
				BW	Body Weight	70	kg	EPA, 2001	
				AT-C	Averaging Time - Cancer	25,550	days	EPA, 2001	
				AT-N	Averaging Time - Non-Cancer	10,950	days	EPA, 2001	
		CHILD	SWIMMING IN EAST POND	CW	Chemical Concentration in Water	See Table 5.3.1 converted to mg/l	mg/l	See Table 5.3.1	Dermally Absorbed Dose (DAD) (mg/kg-day) = DA-event x EV x ED x EF x SA x 1/BW x 1/AT where for organic compounds, Absorbed Dose per Event (DA-event) (mg/cm2-event) = 2 FA x Kp x CW x CF x SQRT((6 x tau-event x t-event)/pi) or DA-event = FA x Kp x CW x ((t-event/(1 + B)) + 2 x tau-event x ((1 + (3 x B) + (3 x B x B))/(1 + B)2)) and where for inorganic compounds, DA-event = Kp x CW x CF x t-event
				FA	Fraction Absorbed Water	Chemical Specific	---	EPA, 2001	
				Kp	Permeability Constant	Chemical Specific	cm/hr	EPA, 2001	
				SA	Skin Surface Area	6,600	cm2	EPA, 2001	
				tau-event	Lag Time per Event	Chemical Specific	hours/event	EPA, 2001	
				t-event	Event Duration	1	hours/event	EPA, 2001	
				B	Ratio of permeability coefficient of a compound through the stratum corneum relative to the permeability coefficient across the viable epidermis	Chemical Specific	---	EPA, 2001	
				EV	Event Frequency	1	events/day	EPA, 2001	
				EF	Exposure Frequency	1	days/year	see text	
				ED	Exposure Duration	6	years	EPA, 1991	
				CF	Volumetric Conversion Factor for Water	0.001	l/cm3	---	
				BW	Body Weight	15	kg	EPA, 2001	
				AT-C	Averaging Time - Cancer	25,550	days	EPA, 2001	
				AT-N	Averaging Time - Non-Cancer	2,190	days	EPA, 2001	

EPA 1995. Supplemental Guidance to RAGS. Region 4 Bulletins, Human Health Risk Assessment (Interim Guidance). Waste Management Division, Office of Health Assessment.
EPA 1992. Dermal Exposure Assessment: Principles and Application. Interim Report EPA/600/8-91/011B. Office of Research and Development, Washington, D.C.
EPA 1991. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Office of Emergency and Remedial Response, Washington, D.C.
EPA 2001: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim

TABLE D.4.2 rme
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FRENCH LIMITED SITE - EAST POND FROM EAST PLUME AREA

Scenario Timeframe:	FUTURE
Medium:	SURFACE WATER
Exposure Medium:	FISH

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
INGESTION	FISHER	ADULT	EATING FISH CAUGHT IN EAST POND	CF	Chemical Concentration in Fish	See Table 5.3.2	mg/kg	See Table 5.3.2	Chronic Daily Intake (CDI) (mg/kg/day) = CF x IR-F x FI x EF x ED x 1/BW x 1/AT
				IR-F	Igestion Rate	0.284	kg/meal	Pao, 1982	
				FI	Fraction Ingested from Contaminated Source	1	unitless	Maximum, 100%	
				EF	Exposure Frequency	12	meals/year	see text	
				ED	Exposure Duration	30	years	EPA, 1991a	
				BW	Body Weight	70	kg	EPA, 1991a	
				AT-C	Averaging Time - Cancer	25,550	days/year	EPA, 2001	
				AT-N	Averaging Time - Non-Cancer	10,950	days/year	EPA, 2001	
		CHILD	EATING FISH CAUGHT IN EAST POND	CF	Chemical Concentration in Fish	See Table 5.3.2	mg/kg	See Table 5.3.2	Chronic Daily Intake (CDI) (mg/kg/day) = CF x IR-F x FI x EF x ED x 1/BW x 1/AT
				IR-F	Igestion Rate	0.284	kg/meal	Pao, 1982	
				FI	Fraction Ingested from Contaminated Source	1	unitless	Maximum, 100%	
				EF	Exposure Frequency	12	meals/year	see text	
				ED	Exposure Duration	6	years	EPA, 1991a	
				BW	Body Weight	15	kg	EPA, 1991a	
				AT-C	Averaging Time - Cancer	25,550	days/year	EPA, 2001	
				AT-N	Averaging Time - Non-Cancer	2,190	days/year	EPA, 2001	

EPA 1991a. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Office of Emergency and Remedial Response, Washington, D.C.

EPA 1991b. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual Supplemental Guidance Standard Default Exposure Factors. OSWER Directive 9285.6-03. Office of Emergency and Remedial Response, Washington, D.C.

EPA 2001: Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim.

Poa et al. 1982. 95th percentile for fin fish.

TABLE D.6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

FRENCH LIMITED SITE - EAST PLUME AREA

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
1,2-Dichloroethane	9.10E-02	(mg/kg-day)-1	0.05	4.55E-03	(mg/kg-day)-1	B2	IRIS	01/12/2003
Trichloroethene	1.10E-02	(mg/kg-day)-1	0.17	1.87E-03	(mg/kg-day)-3	B2	HEAST (2)	1990
Vinyl chloride	7.20E-01	(mg/kg-day)-1	0.05	3.60E-02	(mg/kg-day)-1	A	IRIS	01/12/2003

(1) Risk Assessment guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment Interim. Appendix B.
(2) Obtained from U.S. EPA, "Health Effects Assessment Summary Tables," Fourth Quarter, FY-1990, OSWER PB90-921104.

Definitions:
IRIS = Intergrated Risk Information Systems
B2 = Probable Human Carcinogen - Indicated sufficient evidence in animals and inadequate or no evidence in humans
A = Human Carcinogen

TABLE D.7.1.RME
CALCULATION OF CHEMICAL CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
FRENCH LIMITED SITE - EAST POND FROM EAST PLUME AREA

Scenario Timeframe:	FUTURE
Receptor Population:	SWIMMER / FISHER
Receptor Age:	ADULT

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk
GROUNDWATER	SURFACE WATER	DERMAL CONTACT AND INGESTION FROM SWIMMING IN EAST POND	INGESTION	1,2-DICHLOROETHANE	0.125	mg/l	1.0E-06	mg/kg/day	9.1E-02	$(mg/kg\text{-}day)^{-1}$	9.5E-08
				TRICHLOROETHENE	0.006	mg/l	5.0E-08	mg/kg/day	1.1E-02	$(mg/kg\text{-}day)^{-1}$	5.5E-10
				VINYL CHLORIDE	0.002	mg/l	1.7E-08	mg/kg/day	7.2E-01	$(mg/kg\text{-}day)^{-1}$	1.2E-08
			Exp. Route Total								1.1E-07
			DERMAL	1,2-DICHLOROETHANE	0.125	mg/l	2.7E-07	mg/kg/day	4.6E-03	$(mg/kg\text{-}day)^{-1}$	1.2E-09
				TRICHLOROETHENE	0.006	mg/l	4.6E-08	mg/kg/day	1.9E-03	$(mg/kg\text{-}day)^{-1}$	8.5E-11
				VINYL CHLORIDE	0.0020	mg/l	4.6E-09	mg/kg/day	3.6E-02	$(mg/kg\text{-}day)^{-1}$	1.6E-10
			Exp. Route Total								1.5E-09
		Exposure Point Total									1.1E-07
	Exposure Medium Total										1.1E-07
	FISH	EATING FISH CAUGHT IN EAST POND	INGESTION	1,2-DICHLOROETHANE	0.150	mg/kg	8.6E-06	mg/kg/day	9.1E-02	$(mg/kg\text{-}day)^{-1}$	7.8E-07
			Exp. Route Total								7.8E-07
		Exposure Point Total									7.8E-07
	Exposure Medium Total										7.8E-07
Total of Receptor Risks Across All Media											8.9E-07

TABLE D.7.1a.RME

CALCULATION OF CHEMICAL CANCER RISKS

REASONABLE MAXIMUM EXPOSURE

FRENCH LIMITED SITE - EAST POND FROM EAST PLUME AREA

Surface Water

Adult

Dermally Absorbed Dose (DAD) (mg/kg-day) = DA-event x EV x ED x EF x SA x 1/BW x 1/AT where for organic compounds, Absorbed Dose per Event (DA-event) (mg/cm2-event) = 2 FA x Kp x CW x CF x SQRT{(6 x tau-event x t-event)/pi}

DAD	2.70E-07	4.57888E-09	4.57596E-08
DA-event	8.94503E-07	1.51654E-08	1.51557E-07

		Units	DCA	VC	TCE
CW	Chemical Concentration in Water	mg/l	0.125	0.0020	0.006
FA (1)	Fraction Absorbed Water	----	1	1	1
Kp (1)	Permeability Constant	cm/hr	0.0042	0.0056	0.0120
SA	Skin Surface Area	cm2	18,000	18,000	18,000
tau-event (1)	Lag Time per Event	hours/event	0.38	0.24	0.58
t-event	Event Duration	hours/event	1.00	1.00	1.00
B (1)	Ratio of permeability coefficient of a compound through the stratum corneum relative to the permeability coefficient across the viable epidermis	----	0	0	0.1
EV	Event Frequency	days/year	1	1	1
EF	Exposure Frequency	days/year	1	1	1
ED	Exposure Duration	years	30	30	30
CF	Volumetric Conversion Factor for Water	l/cm3	0.001	0.001	0.001
BW	Body Weight	kg	70	70	70
AT-C	Averaging Time - Cancer	days	25,550	25,550	25,550
AT-N	Averaging Time - Non-Cancer	days	10,950	10,950	10,950

(1) Risk Assessment guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment Interim. Appendix B. Exhibit E-3

TABLE D.7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS

REASONABLE MAXIMUM EXPOSURE

FRENCH LIMITED SITE - EAST POND FROM EAST PLUME AREA

Scenario Timeframe:	FUTURE
Receptor Population:	SWIMMER / FISHER
Receptor Age:	CHILD

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
GROUNDWATER	SURFACE WATER	DERMAL CONTACT AND INGESTION FROM SWIMMING IN EAST POND	INGESTION	1,2-DICHLOROETHANE	0.125	mg/l	9.8E-07	mg/kg/day	9.1E-02	(mg/kg-day)$^{-1}$	8.9E-08
				TRICHLOROETHENE	0.006	mg/l	4.7E-08	mg/kg/day	1.1E-02	(mg/kg-day)$^{-1}$	5.2E-10
				VINYL CHLORIDE	0.002	mg/l	1.6E-08	mg/kg/day	7.2E-01	(mg/kg-day)$^{-1}$	1.1E-08
			Exp. Route Total								1.0E-07
			DERMAL	1,2-DICHLOROETHANE	0.33	mg/l	9.2E-08	mg/kg/day	4.6E-03	(mg/kg-day)$^{-1}$	4.2E-10
				TRICHLOROETHENE	0.006	mg/l	1.6E-08	mg/kg/day	1.9E-03	(mg/kg-day)$^{-1}$	2.9E-11
				VINYL CHLORIDE	0.0020	mg/l	1.6E-09	mg/kg/day	3.6E-02	(mg/kg-day)$^{-1}$	5.6E-11
			Exp. Route Total								5.1E-10
		Exposure Point Total									1.0E-07
	Exposure Medium Total										1.0E-07
	FISH	EATING FISH CAUGHT IN EAST POND	INGESTION	1,2-DICHLOROETHANE	0.150	mg/kg	8.0E-06	mg/kg/day	9.1E-02	(mg/kg-day)$^{-1}$	7.3E-07
			Exp. Route Total								7.3E-07
		Exposure Point Total									7.3E-07
	Exposure Medium Total										7.3E-07
Total of Receptor Risks Across All Media											**8.3E-07**

TABLE D.7.2a.RME
CALCULATION OF CHEMICAL CANCER RISKS
REASONABLE MAXIMUM EXPOSURE

FRENCH LIMITED SITE - EAST POND FROM EAST PLUME AREA
Surface Water

Child

Dermally Absorbed Dose (DAD) (mg/kg-day) = DA-event x EV x ED x EF x SA x 1/BW x 1/AT where for organic compounds, Absorbed Dose per Event (DA-event) (mg/cm2-event) = 2 FA x Kp x CW x CF x SQRT{(6 x tau-event x t-event)/pi}

DAD	9.24E-08	1.56699E-09	1.566E-08
DA-event	8.94503E-07	1.51654E-08	1.51557E-07

		Units	DCA	VC	TCE
CW	Chemical Concentration in Water	mg/l	0.125	0.0020	0.006
FA (1)	Fraction Absorbed Water	----	1	1	1
Kp (1)	Permeability Constant	cm/hr	0.0042	0.0056	0.0120
SA	Skin Surface Area	cm2	6,600	6,600	6,600
tau-event (1)	Lag Time per Event	hours/event	0.38	0.24	0.58
t-event	Event Duration	hours/event	1.00	1.00	1.00
B (1)	Ratio of permeability coefficient of a compound through the stratum corneum relative to the permeability coefficient across the viable epidermis	----	0	0	0.1
EV	Event Frequency	days/year	1	1	1
EF	Exposure Frequency	days/year	1	1	1
ED	Exposure Duration	years	6	6	6
CF	Volumetric Conversion Factor for Water	l/cm3	0.001	0.001	0.001
BW	Body Weight	kg	15	15	15
AT-C	Averaging Time - Cancer	days	25,550	25,550	25,550
AT-N	Averaging Time - Non-Cancer	days	2,190	2,190	2,190

(1) Risk Assessment guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment Interim. Appendix B. Exhibit B-3

TABLE D.9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FRENCH LIMITED SITE - EAST PLUME AREA

Scenario Timeframe:	FUTURE
Receptor Population:	SWIMMER / FISHER / RESIDENT
Receptor Age:	ADULT

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
GROUNDWATER	SURFACE WATER	DERMAL CONTACT AND INGESTION FROM SWIMMING IN EAST POND	1,2-DICHLOROETHANE	9.5E-08		1.2E-09		9.6E-08					
			TRICHLOROETHENE	5.5E-10		8.5E-11		6.4E-10					
			VINYL CHLORIDE	1.2E-08		1.6E-10		1.2E-08					
			Chemical Total	1.1E-07		1.4E-09		1.1E-07					
		Exposure Point Total						1.1E-07					
	Exposure Medium Total							1.1E-07					
	FISH	EATING FISH CAUGHT IN EAST POND	1,2-DICHLOROETHANE	7.8E-07				7.8E-07					
			Chemical Total	7.8E-07				7.8E-07					
		Exposure Point Total						7.8E-07					
	Exposure Medium Total							7.8E-07					
Medium Total													
Receptor Total							Receptor Risk Total	8.9E-07				Receptor HI Total	

TABLE D.9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FRENCH LIMITED SITE - EAST PLUME AREA

Scenario Timeframe:	FUTURE
Receptor Population:	SWIMMER / FISHER / RESIDENT
Receptor Age:	CHILD

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
GROUNDWATER	SURFACE WATER	DERMAL CONTACT AND INGESTION FROM SWIMMING IN EAST POND	1,2-DICHLOROETHANE	8.9E-08		4.2E-10		8.9E-08					
			TRICHLOROETHENE	5.2E-10		2.9E-11		5.5E-10					
			VINYL CHLORIDE	1.1E-08		5.6E-11		1.1E-08					
			Chemical Total	1.0E-07		5.1E-10		1.0E-07					
		Exposure Point Total						1.0E-07					
	Exposure Medium Total							1.0E-07					
	FISH	EATING FISH CAUGHT IN EAST POND	1,2-DICHLOROETHANE	7.3E-07				7.3E-07					
			Chemical Total	7.3E-07				7.3E-07					
		Exposure Point Total						7.3E-07					
	Exposure Medium Total							7.3E-07					
Medium Total													
Receptor Total							Receptor Risk Total	8.3E-07			Receptor HI Total		